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L O G G I N G

The

Principles, Methods, and Costs of Operation West of the Cascades in Oregon and Washington, with Respect to Timber Appraisals.

Part 3

by

W. H. Gibbons, Forest Examiner.

District 6
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PART III

WIRE ROPE (Ground Yarding and Loading)

General.

Under this heading will be discussed the cost of wire rope per M feet as it relates to cost of transporting the logs over the ground from the stump to the landing and loading them on the cars. The cost of wire rope used in loading is included here rather than under the cost of loading for the following reasons:

(1) The cost of wire rope used in loading is not large.

(2) The cost of wire rope per M feet is generally given under a special heading and is not segregated into yarding and loading.

(3) Since most of the wire rope is used in yarding it is more logical to discuss it under yarding than under loading.

Logging rope is generally made of steel and hemp; steel for the strands; hemp for the core. The steel should be tough; the hemp, long fibred. The strands as a rule are composed of nineteen wires each, which may be of the same size or of two sizes. As a general thing the wire is of two sizes, one large wire in the center, encircled by nine smaller ones, which wires in turn are encircled by nine larger wires. Ropes are made six, seven and eight strands. Logging ropes are gen-

erally made with six plain steel strands, as it seems that the six-strand rope meets the chief requirements,- strength and flexibility. The nature of the ground and the quality of the soil have a bearing on the rope used. Steep, rocky ground where the wire is subject to wear against stones, requires a harder wire than comparatively level ground with clay for the line to work on.

The cost of cable per M feet is a rather heavy item of expense. It is an item whose cost varies greatly in different camps. This latter is indicated by a table showing the comparative cost of wire rope per M feet at several camps. The reason for this variation in cost can be best brought out through an enumeration and brief discussion of the several factors affecting the cost of wire rope per M feet.

Factors Affecting the Cost of Wire Rope per M Feet.

(1) Cost per unit of measure.

(2) Size of rope.

(3) Length of haul. It is obvious that the cost per M feet will be greater where the average maximum haul is 1,000 feet than where it is 700 feet.

(4) Number of machines used to transport the logs from the stump to the landing. This in a way is the same factor as the third one.

(5) Size of timber.

(6) Ground conditions,- irregularities, rock, slope,

etc.

(7) Care of lines.

(8) Life expected of lines. Some foremen use lines longer than others.

(9) Items included in wire rope account.

Care in Collecting Cost Data Dealing with the Cost of Wire Rope per M Feet is Necessary.

An accountant made the following statement: "There are different ways of charging the cost of wire rope, and each has its own points of merit. One way is to make an arbitrary charge at a certain rate per thousand feet of logs produced and credit this to the wire rope account, which account is charged with all cables purchased. The arbitrary charge is based on an estimate and is changed as experience indicates. It, however, is faulty for this reason - that it does not show readily when a large expenditure for cable is made and a report of the cost of the cable from any particular camp will not indicate the actual consumption but merely the supposed consumption. A better way is to charge the camp equipment in the first instance with the amount of cable necessary for proper equipment and then receive a report every month giving the quantity of serviceable cable still on hand and by adjusting the cable account the amount consumed during the month may be determined, and it will readily appear if there has been an excessive loss." The latter method is possibly used by most of the camps who keep a

wire rope account. The trouble with the method is that it is difficult to estimate the value of the wire rope on hand at the end of a month, a six-months' period, or at the end of the year. If the estimated value of the rope on hand is too high or low, the cost per M feet appearing in the cost statement will be too high or low.

It has been pointed out that most camps have a wire rope account in which they include the cost of cables used in yarding and loading, also the cable used in making chokers, tag lines, yarding lines, crotch lines, etc. Some camps keep a rigging account in which they include chokers, tag lines, yarding lines, crotch lines, etc. This suggests that an attempt should be made to determine just what is included in this item of cost and how it is arrived at.

Straw Line.

This line is used in running out the trip line. The yarding crew takes the straw line around the opposite way after hanging up all the blocks and putting out the whistle wire. The line is put in the trip blocks the same way as the main trip line. The engine, reeling in the straw line, pulls the trip line out, around, and back to the main line drum. The line should be as long as the trip line and about ½" in diameter.

Size of Different Kinds of Lines.

The size of lines varies in different camps, due to different conditions and to what the superintendent thinks is

right.

As a rule the thickness of main yarding lines ranges from 1-1/8" to 1-3/8"; trip lines from ½" to 7/8". Straw lines are generally ½" thick. In one camp where the logs average 1,900 feet in volume, the country mountainous and badly broken up, the main yarding line is 1-3/8" thick, and the trip line 7/8" thick. In another camp where the logs averaged about 600 feet in volume, the country practically level, the main yarding line is 1¼" thick and the trip line 5/8" thick. In a third camp where conditions were practically the same a 1-1/8" main yarding line was used with a ½" trip line. In still another camp where the logs averaged about 1,000 feet in volume and the country was bad, a 1¼" main yarding line was used with a ¾" trip line.

Average Life of Lines of Different Kinds Measured in the Amount of Timber Handled.

This is a difficult thing to estimate. On this estimate, generally speaking, will depend the accuracy of the estimated cost of wire rope per M feet. The life will depend on the following factors:

(1) Size of cable.

(2) Size of timber.

(3) Ground conditions - irregularities, rock, slope, etc.

(4) Care of lines.

(5) Life expected of lines. Some foremen use lines longer than others.

Generally speaking, it may be stated that a yarding line should handle three, four or five million feet. If the "show" is particularly bad the yarding lines may not average more than two million. Occasionally a line of this kind will average as much as eight million. Yarding lines on the average, good and bad "shows" for a large section of country, possibly handle four million feet. Roading lines as a rule will last a little longer than yarding lines. Trip lines possibly last longer than yarding lines. Some superintendents estimate that they last no longer; others figure that they last nearly twice as long. It may be that trip lines on the average last one and one-half times as long as yarding lines.

The actual life of lines as indicated by use in several camps, and the estimated life of lines given by several camp superintendents and foremen, are given in the following statements:

Camp 1 (Number has no significance)

<u>Size of Lines</u> -

Main yarding line - 1-3/8"

Trip line - 7/8"

<u>Life of Main Yarding Line.</u>

The lines used during 1912 averaged four million feet per line. Eight million feet were handled with one line. One

line lasted only two days; another lasted only three weeks.

Timber and Ground.

The country is mountainous and badly broken up. The slopes for the most part are steep. Logs were moved both up and down-hill. The logs averaged about 1,900 feet. Logs were yarded an average maximum distance of 900 feet.

Camp 2.

Size of Lines -

Main yarding line - 1-1/8"

Trip line - 1/2"

Life of Main Yarding Line.

The yarding lines used during the year 1912 averaged from four to six million.

Timber and Ground.

The ground was practically level, and quite free of down timber. The logs averaged about 550 feet in volume.

Camp 3.

Size of Lines -

Main yarding line - 1¼"

Trip line - ¾"

Life of Main Yarding Line.

The yarding lines used during the year 1912 averaged from four to five million.

Life of Trip Lines.

The trip lines averaged about 5½ million to the line.

Timber and Country.

The ground was badly broken up by pot-holes, hummocks, small ravines, etc. It was both hilly and level; where hilly the logs were moved down-hill. The volume of the average log was about 1,000 feet. The average output per yarder per yarding day was about 40 M feet.

Average Length of Different Kinds of Lines.

The length of the yarding lines will, of course, depend as a general thing on the maximum yarding distance. The relative length of the trip lines when compared with the yarding line will vary. It may be safe to figure that the trip line will be a little more than two and one-half times as long as the yarding line. The straw line will be as long as the trip line.

Cost of Wire Rope per M Feet.

One authority in discussing wire rope in 1911 dealt with the cost as follows: "The actual cost per thousand depends on the care given the line and the system of logging used. In the system of ground yarding mostly used at present - yarding directly to the track and loading - the average cost is about 12½¢ per M feet. More attention is paid to the yarding lines than to any other. Few loggers but keep pretty close track of these, but not many who can tell if the others are giving good service. Yet the cost of the yarding lines does

not total quite half his wire cost, so that the other lines should receive some attention. If the haulback is carelessly strung it will have a great deal of unnecessary friction to overcome. A good yarding line will haul from four to six million feet, and the cost per thousand will be a little above five cents. A haulback line should wear out at least two yarding lines. The cost per thousand when using the overhead cableway system (he had the Lidgerwood system in mind) is about a standoff with the yarding and loading system. If skid roads are used, about 13½ cents per thousand for each mile of haul should be added to the cost by the yarding and loading method, making the total cost for the line when using a one-mile skid road about 26 cents per thousand."

Table Showing the Comparative Cost of Wire Rope per M Feet at Several Camps. (Camp numbers have no significance.)

Camp	Time Based On	Year	Cost per M Feet
1	6 months	1912	$.072
2	1 year	1912	.108
3	1 year	1912	.197
	1 year	1911	.15
4	1 year	1912	.142
5	1 year	1912	.229
	1 year	1911	.403
	1 year	1910	.495
6	1 year	1911	.165

Discussion of Table Showing the Comparative Cost of Wire Rope per M Feet at Several Camps:

Camp 1.

The cost includes the wire rope used in yarding and loading. The size of the lines were - main line 1-1/8"; trip line ½". Logs were yarded direct at an average distance of about 650 feet. The ground was practically level, and never steep enough to cause the logs to run. It was quite free of pot-holes and there was little brush and down timber and no rock. A gin pole was used in loading, the motive power being furnished by a spool on the yarder. 10"x11" Washington Iron Works yarders were used. The logs averaged 550 feet. Chokers were made from the old main lines. The donkeys were not equipped with straw lines.

Camp 2.

The cost includes the main line, trip line and main loading line used during the year 1912, which was based on the year's output and the following:

Inventory value, Jan. 1, 1912 - - -	$2,646.65
Purchased in 1912 - - -	3,994.78
	$6,641.43
Inventory value, Jan. 1, 1913 - - -	1,168.10
Loss - - -	$5,473.33

The inventory values are necessarily estimates, and the accuracy of the cost of wire rope per M feet for the year will depend on the accuracy of these estimates. There is, however, no way of getting away from estimates of this character.

Lines of the following sizes were used:

Main line - - - - - - - $1\frac{1}{4}$"
Trip line - - - - - - - 5/8"
Loading line- - - - - - 1-1/8"

The cost of $.108 per M feet does not include the cost of rigging, such as chokers, tag lines, yarding lines, and crotch lines for loading, which cost amounted to $.045 per M feet.

All the timber was single-hauled and the average maximum yarding distance was about 800 feet. The ground was practically level. No places were steep enough to cause the logs to run. No rock had to be contended with. Not less than two logs were yarded at a turn; sometimes three or four; and occasionally as many as five. The yarders were driven at practically their highest speed. Comparatively speaking, the lines were given hard usage. The logs averaged about 600 feet to the log. 10x11" Willamette yarders were used.

Camp 3.

The cost includes the wire rope used in yarding and loading; also chokers, yarding lines, crotch lines, etc.

All timber was yarded direct to the landing at an average maximum distance of about 800 feet. 12x12" Washington Iron Works yarders were used. The ground in places was practically level; in others, hilly. Where hilly the logs were moved down-hill. The ground was badly broken up. The logs averaged 1,000 feet in volume. The output per yarder per

yarding day ranged from 37 to 45 M feet.

Camp 4.

The cost includes the main yarding line, trip line, and main loading line used during the year 1912. It does not include the cost of rigging - such as chokers, tag lines, yarding lines and crotch lines for loading rigs, which cost amounted to $.044 per M feet.

The "show" from the standpoint of the ground represented an average one as the country is not particularly rough or badly broken up. From the standpoint of brush, rotten stumps and down timber it was much worse than the average. Part of the timber was double-hauled; just how much it cannot be stated. The average output per yarder per yarding day was about 55 M feet. The volume of the average logs was about 675 feet.

Camp 5.

The cost of $.229 per M feet includes the cost of main yarding lines, trip lines and main loading lines used in 1912. It does not include the cost of rigging, such as chokers, tag lines, yarding lines, crotch lines, etc., which cost amounted to $.064 per M feet.

The country is mountainous and badly broken up. The slopes in general were steep. Logs were moved both up and downhill. No rock was encountered. The average scale per yarder per yarding day was about 70 M feet. The scale of the average

log was about 1,900 feet. The following lines were used:

Mainline - - - - - - - $1\frac{1}{4}$" and 1-3/8"
Trip line- - - - - - - 7/8"

The average maximum yarding distance was about 900 feet. About one-third of the timber was double-hauled.

The cost of $.403 includes the cost of yarding and loading lines and rigging for 1911. It is not possible to state the average maximum distance from the stump to the landing. It is known that some of the timber was moved as much as 7,500 feet; some of it, 4,000 feet; and that most of it was moved as far as 2,000 feet.

The wire rope cost of $.495 for 1910 includes the same items as the cost for 1911. It is not possible to discuss this cost.

Camp 6.

This data was not gathered by the writer and so it is not possible to discuss it. It is authentic.

Estimating the Cost of Wire Rope per M Feet Used in Yarding.

Two methods can be used. The first is to use the actual cost per M feet in a camp where conditions are approximately the same as the case being dealt with. The second method briefly stated is to estimate the cost per M feet by using the following factors:

(1) Kinds of lines.

(2) Life of average lines of different kinds measured in the amount of timber handled.

(3) Average length of different kinds of lines.

(4) Size of different kinds of lines.

(5) Cost per given unit of measure of lines of different sizes.

(6) Freight on lines.

It is obvious that, with the above factors, it is possible to estimate the cost of wire rope per M feet. These factors will be discussed later under special headings.

The second method can be modified as follows: Estimate the cost per M feet as suggested by the second method and then check the results by the first method, changing the estimate as judgment suggests.

The method of estimating the wire cost per M feet is illustrated later in this circular.

Second Method of Estimating the Cost of Wire Rope per M Feet Illustrated.

A Service scaler in discussing wire rope in connection with a Service sale submitted the following: "On this sale the donkeys are equipped with wire rope as follows: (Discussion submitted in June, 1913)

Main Line

Donkeys	Size	Length (feet)	Cost per Foot	Cost per Line	Frt.	Total Cost	Output M feet	Cost per M Feet
12x12 Roader	1-1/4"	1700	$.234	$397.80	$10.23	$408.03	5000	$.0816
12x12 Yarder	1-1/4"	900	.234	210.60	6.10	216.70	4500	.0482
12x12 Yarder $10\frac{1}{2}$x$10\frac{1}{4}$)	1-1/4"	1100	.234	257.40	6.68	264.08	4500	.0587
On incline)	1-1/8"	1200	.194	232.80	5.92	238.72	3000	.0796

Haulback Line

Donkeys	Size	Length (Feet)	Cost per Foot	Cost per Line	Frt.	Total Cost	Output M Feet	Cost per M Feet
12x12 Roader	5/8"	4000	$.068	$272.00	$ 6.07	$278.07	9000	$.0309
12x12 Yarder	7/8"	2400	.122	292.80	7.13	299.93	4500	.0666
12x12 Yarder $10\frac{1}{2}$x$10\frac{1}{4}$)	7/8"	2400	.122	292.80	7.13	299.83	4500	.0666
On incline)	7/8"	2400	.122	292.80	7.13	299.93	4500	.0666

"The main lines for the construction donkey are partially worn-out lines from the incline donkey or yarders, but as I have charged the whole cost to the incline donkey and yarders, no cost need be figured for the construction donkey. Haulback lines that are badly worn and broken are used on the construction by splicing the better parts together. Therefore, with two "sides" operating, the cost for cable can be classed as either direct yarding or yarding and loading. The yarder with 900 feet of main line, and 2400 feet of haulback line,

totalling $.1148 per M feet, used with the roader whose lines cost $.1125 per M feet, would make the total cost of yarding and roading lines come to $.2273.

"The prices for wire rope are standard list prices minus the contract discounts obtained by the _____ Logging Company. The freight is figured from the rate per hundred pounds and the weight of the wire and reel."

It cannot be stated whether the costs per M feet given in the tabulation are based on the actual average life of the lines in this camp or an estimated life. It may be stated that the life of the lines in M feet seems to be right.

Variation in Cost of Wire Rope per M Feet May be Due to Some Extent to the Method of Accounting.

It has been pointed out that the cost of wire rope per M feet may fluctuate by years simply as a result of the method of accounting. The following is the wire rope cost per M feet by months for five months. It is clear that the variation in cost is due to the method of accounting rather than to variable conditions.

Wire Rope Cost per M feet at a Camp for Five Months.

Item	Month	Cost per M Feet
Wire rope	January	$.882
" "	February	.276
" "	March	.109
" "	April	.053
" "	May	.159

The output by months follows:

Month	Output -- Feet
January	1,407,792
February	1,706,342
March	3,250,384
April	3,625,404
May	3,723,754

The foreman stated in giving the total logging costs that the months of January and February should not be taken as average costs, as during these months considerable repair work, landing construction and spur extensions was done.

The table of wire rope costs by months is of no value other than illustrating how easy it is to secure costs that do not represent averages.

Rigging and Main Loading Lines.

So far only the costs of main yarding, trip and straw lines have been discussed. Rigging and main loading lines have not been dealt with. Where the wire rope account is segregated into wire rope and rigging accounts, it is customary as a rule to include the main loading line in the wire rope account and to include crotch lines, yarding and tag lines, etc., and chokers in the rigging account.

This is not an easy item of expense to estimate. The relative cost per M feet, however, is not large, and comparatively little attention has been given to it by operators in the way of cost records. The length, size and life of loading lines vary with the type of loading rig and the size of the log

handled. Yarding and tag lines may be made from old main yarding lines, and so no cost may be charged against this equipment. In other camps the chokers, tag lines, etc., will be made from new lines. This results in confusion as far as running down the cost of the equipment goes.

It seems to the writer that it is hardly practical to estimate the cost of this equipment by using the factors of cost and life. It probably will be best to use the cost per M feet of some camp working under similar conditions.

Cost of Rigging per M Feet (1)

The cost of rigging including chokers, tag lines, etc., and not including the main loading, at one camp amounted in 1912 to $.064 per M feet. It would seem that the cost should never be higher than this. The country was mountainous and badly broken up; the slopes for the most part being steep. Logs were moved both up and down-hill. The yarders were powerful and output was not sacrificed to reduce the wear and tear on equipment. The logs averaged 1,800 feet in volume. New lines were used.

Cost of Rigging per M Feet (2)

The cost of rigging, including chokers, tag lines, crotch lines, etc., and not including the main loading lines, at a camp in 1912 amounted to $.044 per M feet. It was possibly an average show as the country is not particularly rough or badly broken up. The logs averaged about 700 feet; one,

two, three or four logs being brought in at a turn, depending on the "show". The average output per yarder per yarding day was about 55 M feet. New lines were used. The donkeys were powerful, driven at high speed and most stress was given to output.

Cost of Rigging per M Feet (3)

The cost of rigging, including chokers, tag lines, yarding lines, crotch lines, etc., and not including the main line, at a camp in 1912 amounted to $.057 per M feet. The country was about as good as can be found in this section. It is practically level for the most part and never steep enough to cause the logs to run. Never less than two logs were brought in at a turn; sometimes three and four, and, occasionally, five. The average output per yarder per yarding day was about 75 M feet. The logs averaged about 700 feet in volume. The lines were new. The yarders were driven at high speed, and most stress was given to output.

Estimating the Cost of Main Loading Lines.

A Service scaler in discussing loading lines made the following statement: "Loading lines are 3/4", 350 feet in length, and two pieces of 11/16" rope, 28 feet long for crotch lines, makes a total length of 406 feet, costing $50; an average of three million feet of logs are loaded, costing $.0166.

Description, etc., Rigging and Main Loading Lines.

The thickness and length of the main loading lines depend on the loading rig and the volume or weight of the logs. The thickness ranges between 5/8" and 1-1/4". The length of main loading lines is discussed under the heading "Loading". A main loading line will handle from four to six million.

Chokers range in length from 18 to 32 feet; in thickness from 1 to 1¼ inches. They are generally the same thickness as the main line.

Tag lines are the same thickness as the main line and are as long as the longest log to be handled.

Yarding lines are generally the same thickness as the main yarding line, and vary in length, depending on the anticipated show and the length of the yarding line used.

Other Lines and Straps Used in Yarding and Loading.

Old lines are used for guying gin poles, block straps, etc.

Cost of Lines per Linear Foot.

The price of wire rope fluctuates. John A Roeblings Sons Co., of California, quoted the following prices on August 29, 1913:

6/19 Plow Steel

9/16"	16¢	per	ft.	less	60	&	5%	or	$6.08	per	100	ft.
5/8"	19¢	"	"	"	"	"	"	or	7.22	"	"	"
1"	43¢	"	"	"	"	"	"	or	16.34	"	"	"
1-1/8"	54¢	"	"	"	"	"	"	or	20.52	"	"	"
1-1/4"	65¢	"	"	"	"	"	"	or	24.70	"	"	"
1-3/8"	79¢	"	"	"	"	"	"	or	30.02	"	"	"

Note.- 6/19 plow steel rope is the rope which is generally used for logging purposes.

8/19 Plow Steel Rope

1"	48¢	per	ft.	less	60	&	5%	or	18.24	per	100	ft.
1-1/8"	60¢	"	"	"	"	"	"	or	22.80	"	"	"
1-1/4"	72¢	"	"	"	"	"	"	or	27.36	"	"	"

Broderick and Bascom quoted the following prices on wire rope on August 29, 1913:

6/19 Yellowstrand

1/2"	$.125	per	ft.	less	50,	2½	&	7½%	or	$5.637	per	100 ft.
9/16"	.14	"	"	"	"	"	"	"	or	6.313	"	" "
5/8"	.165	"	"	"	"	"	"	"	or	7.440	"	" "
3/4"	.22	"	"	"	"	"	"	"	or	9.921	"	" "
7/8"	.29	"	"	"	"	"	"	"	or	13.077	"	" "
1"	.37	"	"	"	"	"	"	"	or	16.685	"	" "
1-1/8"	.46	"	"	"	"	"	"	"	or	20.743	"	" "
1-1/4"	.56	"	"	"	"	"	"	"	or	25.252	"	" "
1-3/8"	.68	"	"	"	"	"	"	"	or	30.664	"	" "
1-1/2"	.80	"	"	"	"	"	"	"	or	36.075	"	" "
1-5/8"	.94	"	"	"	"	"	"	"	or	42.388	"	" "
1-3/4"	1.10	"	"	"	"	"	"	"	or	49.603	"	" "
1-7/8"	1.25	"	"	"	"	"	"	"	or	56.367	"	" "
2"	1.34	"	"	"	"	"	"	"	or	60.426	"	" "

6/19 Plow Steel

1/2"	$.11	per	ft.	less	55	&	5%	or	$4.702	per	100	ft.
9/16"	.12	"	"	"	"	"	"	or	5.130	"	"	"
5/8"	.14	"	"	"	"	"	"	or	5.985	"	"	"
3/4"	.19	"	"	"	"	"	"	or	8.122	"	"	"
7/8"	.24	"	"	"	"	"	"	or	10.260	"	"	"
1"	.31	"	"	"	"	"	"	or	13.252	"	"	"
1-1/8"	.38	"	"	"	"	"	"	or	16.245	"	"	"
1-1/4"	.46	"	"	"	"	"	"	or	19.665	"	"	"

6/19 Plow Steel, Cont'd.

1-3/8"	$.56	per	ft.	less	55 & 5%	or	$23.940	per	100	ft.
1-1/2"	.66	"	"	"	" " "	or	28.215	"	"	"
1-5/8"	.77	"	"	"	" " "	or	32.917	"	"	"
1-3/4"	.90	"	"	"	" " "	or	38.475	"	"	"
1-7/8"	1.02	"	"	"	" " "	or	43.605	"	"	"
2"	1.16	"	"	"	" " "	or	49.590	"	"	"

Weight of Wire Rope.

The approximate weight of 6/19 Yellow Strand is as follows:

1/2"	.39	pounds	per	foot
9/16"	.50	"	"	"
5/8"	.62	"	"	"
3/4"	.89	"	"	"
7/8"	1.20	"	"	"
1"	1.58	"	"	"
1-1/8"	2.00	"	"	"
1-1/4"	2.45	"	"	"
1-3/8"	3.00	"	"	"
1-1/2"	3.55	"	"	"
1-5/8"	4.15	"	"	"
1-3/4"	4.85	"	"	"
1-7/8"	5.55	"	"	"
2"	6.30	"	"	"

Freight on Lines.

The freight on equipment, materials, etc., will be dealt with in another part of this report. In a given case, eliminating the question of life, it is a simple matter to estimate the freight charge per M feet on wire rope.

BLOCKS AND HOOKS USED IN GROUND YARDING AND LOADING

General.

One authority in discussing the size of blocks as they relate to wear and tear on lines made the following statement in 1911:

"Sheaves of as great diameter as possible should be used. For 1" line they should not be less than 12 inches in diameter, and for 1-1/8" to 1¼" line, from 14 inches to 18 inches. The size of sheave recommended in catalogs for 1¼" line is 4-ft. This cannot be allowed in the woods, but small sheaves should be avoided. If they are badly worn they will have grooves with sharp edges between, which will cut the wire; if they are out of shape they will not roll - they are little better than a 'siwash'."

Another authority in commenting on blocks and sheaves made the following statements: "In my experience I have found that too much attention cannot be paid to the condition of your blocks and sheaves; the size of the sheaves is necessarily small on account of the weight - in fact, too small to get the best results, but sheaves with grooves of proper size (I mean by this, don't use a sheave with a groove made for a 5/8" or a ¾" line for a 1¼" line) and see that the sheaves work freely in the block, of liberal diameter, of good quality - <u>they are practically unbreakable</u> and I have sheaves

in butt chain blocks where the sheaves have been in use three years, that show little perceptible wear, and to me m-a-n-g-a-n-e-s-e spells economy in wire cable."

The standardization committee of the Pacific Logging Congress made the following recommendation in 1913:

For trip blocks we recommend the adoption of five different sized blocks with sheaves, as follows:

Trip Blocks.

9" x 1¼"	x 1-15/16"	hub	length	3"
12" x 1¼"	x 1-15/16"	"	"	3"
14" x 1½"	x 2-7/16"	"	"	3"
18" x 1½"	x 2-7/16"	"	"	4"
24" x 2"	x 3-7/16"	"	"	5"

All of the above blocks to be grooved for a ¾" line.

Yarding Blocks.

10" x 2"	x 2-7/16"	3" hub	grooved	for	1¼" line
12" x 2½"	x 2-15/16"	3½" "	"	"	1½" "

Butt Chain Blocks.

16" x 8" x 3-7/16"	8" hub	These three sheaves, if grooved for line, to take 1½" line.
20" x 8" x 3-7/16"	8" "	
24" x 8" x 3-7/16"	8" "	

Cost of Blocks, Hooks, Rollers and Repair Parts Used In Yarding and Loading.

The cost of blocks, hooks, rollers and repair parts per M feet in a camp in 1912 amounted to $.0240 per M feet.

The country was mountainous and badly broken up, the slopes for the most part being steep. Logs were moved both up and downhill. About one-third of the timber was double-hauled. The logs were yarded an average maximum distance of about 900 feet. The logs averaged about 1900 feet in volume.

Cost and Weight of Logging Blocks.

The following is the cost of Skookum logging blocks, f.o.b. Portland, Oregon, in September 1912; also their weight. These blocks are made by the Columbia Engineering Works of Portland, Oregon.

Butt Chain Lead Block

No. 109.5	16x5"	weight 250 lbs.	price $51.00
No. 110	20x5"	weight 350 lbs.	price $68.00
No. 100.8	20x8"	weight 450 lbs.	price $80.75

Approximate Cost of Spares for the Above Blocks

	For #109.5	For #110	For #110.8
Tool Steel shackle and pin	$6.00	$10.00	$12.00
Pair cast steel sides	20.00	26.50	26.50
Pair dirt proof caps	1.00	1.00	1.00
Hardened steel sheave pin	4.50	4.50	5.50
Bronze bushing	5.50	5.50	7.50
Bronze bushed manganese steel sheaves	23.00	32.50	42.50
Size of sheave pin	3x7½"	3x7½"	3x10½"

Butt Chain Lead Block

				Columbia Metal Sheave	Cast Steel Sheave	Manganese Steel Sheave
#7	9x7"	weight 140 lbs.	Price	$24.00	$27.60	$32.00
#8	14x6½"	" 270 "	"	33.00	38.25	44.50
#9	14x9"	" 325 "	"	37.40	42.50	48.50
#11	16x9"	" 375 "	"		46.75	55.25

Approximate Cost of Spares for the Above Block

	For 9x7 #7	For 14x6½ #8	For 14x9 #9	For 16x9 #11
Tool steel shackle and pin	$5.50	$ 6.00	$8.00	$9.00
Pair cast steel block sides	9.00	14.50	14.50	16.50
Hardened steel pin	3.25	3.50	3.75	3.75
Bronze bushing	5.00	5.50	7.00	7.00
Bronze bushed Columbia metal sheave	11.00	15.00	18.00	
Bronze bushed cast steel sheave	15.00	21.00	24.00	26.00
Bronze bushed manganese steel "	20.00	28.50	31.00	35.00
Diameter of sheave pin	2½"	3"	3"	3"

Lead Block. This block is particularly made for use when frequent changes in the position of the lead block is necessary. It may be used in moving donkeys.

No. 100. Size 10x3", weight 125 lbs. Size of pin 2½x3". Shackle 2¼ tool steel.

With bronze bushed Columbia metal sheave - - - - $21.25

Approximate Cost of Spares for the Above Block.

Tool steel shackle 2¼ - - - - - - - - - - - - - - - -	$5.00
Pair cast steel block sides - - - - - - - - - - - - -	11.00
Hardened steel pin and oil cup 2½x3 - - - - - - - -	3.00
Bronze bushing- - - - - - - - - - - - - - - - - - - -	2.00
Columbia metal sheave, bronze bushed- - - - - - - -	6.00

Double Hinge Yarding Block

For 1, 1-1/8 and 1¼" wire rope; size of pin 2½x3".

No. 2 - Size 9x2"; weight 90 lbs.

With bronze bushed Columbia metal sheave	$15.70
" " " cast steel "	17.00
" " " manganese steel "	18.50

No. 27 - Size 10x2"; weight 100 lbs.

With bronze bushed Columbia metal sheave - - - - - -	17.00
" " " cast steel "	19.00
" " " manganese steel "	20.50

For price of block without forgings deduct $7.00 from the above prices.

Approximate Cost of Spares for the Above Blocks.

	No. 2	No. 27
Hook, swivel, yoke and link	$7.00	$7.00
Pair cast steel sides	6.50	8.00
Sheave pin 2½x3", with oil well	1.50	1.50
Bronze bushing	1.50	1.50
Bronze bushed Columbia metal sheave	3.50	4.00

	No. 2	No. 27
Bronze bushed cast steel sheave	$5.00	$5.75
" " manganese steel "	6.50	7.50

Shackle Yarding Block

Size of shackle, 2" tool steel.

	8"	9"	10"
With bronze bushed Columbia metal sheave	$12.00	$13.00	$14.75
" " " cast steel "	13.00	14.50	16.40
" " " manganese steel "		15.75	18.00

Approximate Cost of Spares for the Above Blocks.

	8"	9"	10"
Hook, swivel, yoke and link	$7.00	$7.00	$7.00
Pair cast steel sides	6.00	6.50	8.00
Sheave pin and oil well	1.50	1.50	1.50
Bronze bushing	1.50	1.50	1.50
Bronze bushed Columbia metal sheave	3.00	3.50	4.00
" " cast steel "	4.25	5.00	5.75
" " manganese steel "	4.25	5.00	5.75
Shackle 2" tool steel	5.50	6.50	7.50

Head Trip Block

Made for 5/8, 3/4 and 7/8" wire rope

Size - 18x1-5/8"

Weight - 115 lbs.

Size of pin - 2-7/16x4"

With bronze bushed cast steel sheave	$23.00
" " " manganese" "	28.00

Approximate Cost of Spares for the Above Blocks.

Steel shackle	$2.00
Pair cast steel sides	10.00
Hardened steel sheave pin	3.25
Bronze bushing	2.50
Bronze bushed cast steel sheaves	12.25
Bronze bushed manganese steel sheaves	17.25

Head Trip Block

No. 14 - Size 14x1½"; weight 80 lbs.; size of pin 2-7/16x3-1/16".

With bronzed bushed Columbia metal sheave	$15.25
" " " cast steel "	17.00
" " " manganese steel "	19.00

No. 132 - Size 12x1½"; weight 54 lbs.; size of pin 2-3/16x3-1/16".

With bronze bushed Columbia metal sheave	$13.25
" " " cast steel "	14.50
" " " manganese steel "	16.00

Approximate Cost of Spares for the Above Blocks.

	No. 14	No. 132
Steel shackle	$2.00	$1.25
Pair cast steel sides	8.00	7.50
Hardened steel sheave pin	2.50	2.25
Bronze bushing	2.00	1.60
Bronze bushed Columbia metal sheave	5.50	4.50
" " cast steel "	7.50	6.00
" " manganese steel "	10.00	8.00

Trip Line Block

No. 18 - Size 9x1¼"; weight 28 lbs.; size of pin 1½x2¼".

With bronze bushed Columbia metal sheave	$6.80
" " " steel "	7.70
" " " manganese "	9.00

Approximate Cost of Spares for the Above Block.

Steel shackle	$.75
Pair cast steel sides	4.00
Hardened steel sheave pin	1.00
Bronze bushing	1.15
Bronze bushed Columbia metal sheave	2.25
" " cast steel sheave	3.25
" " manganese steel sheave	4.75

Light Yarder Loading Block.

No. 114 - Size 6x1½"; size of pin 1½x2¼"; weight 40 lbs.

With bronze bushed Columbia metal sheave	$12.00
" " " cast steel "	12.20

Approximate Cost of Spares for the Above Block

Tool steel hook with swivel and yoke	$5.50
Pair cast steel sides	4.50
Pair dirt proof caps	1.00
Sheave pin 1½x2¼", complete with oil well	1.00
Bronze bushing	1.25
Bronze bushed Columbia metal sheave	2.00
" " cast steel "	2.50

The above block with shackle of 2" steel instead of hook, swivel and yoke, costs $3.00 less than the prices set forth above.

Cost of Hooks.

Diamond "M" Loading Hooks.

These hooks are used for loading logs with a gin pole and crotch line with an overhead rig.

Prices (approximate)

1¼",	octagon,	per	pair- - - - - - -	$8.00
1½"	"	"	" - - - - - - -	10.00
1-5/8"	"	"	" - - - - - - -	12.50
1¾"	"	"	" - - - - - - -	15.00
2"	"	"	" - - - - - - -	18.00
2¼"	"	"	" - - - - - - -	21.00

Diamond "M" Choker Hooks.

Prices (approximate)

1x2"	for ¾" line - - - - - - - - - - -	$1.50
1¼x3"	" 7/8" and 1" line- - - - -	2.00
1¼x4"	" 1-1/8" and 1¼" line - - -	2.50
1½x5"	" 1-3/8" hose and larger- -	3.50

The "Perfect" Choker Hooks.
Prices (approximate)

1x2"	for ¾" line- - - - - - - - - - -	-$5.00
1¼x3"	" 7/8" and 1" line - - - - - -	6.50
1¼x4"	" 1-1/8" and 1½" line- - - -	8.00
1½x5"	" 1-3/8" and larger- - - - -	-10.00

The "Peter's" Choker Hook.

Prices (approximate)

7/8" - - - - - - - - - - - - - - -	each	$3.75
1" - - - - - - - - - - - - - - - -	"	4.50
1-1/8" - - - - - - - - - - - - - -	"	5.50
1¼"- - - - - - - - - - - - - - - -	"	6.50
1-3/8" - - - - - - - - - - - - - -	"	8.50

Diamond "M" Butt Chain and Lone Hooks.

Prices (approximate)

1-1/8"	for	trip	lines	$ .75
1¼"	"	"	"	1.00
1½"	"	yarding"		1.50
1¾"	"	"	"	2.00
2"	"	main line		2.50
2¼"	"	"	"	3.50
2½"	"	"	"	4.50

"Waterhouse" Butt Hooks.

Prices (approximate)

Complete with clevis, each - - - - - - - $15.00

Cost of Swivels.

Diamond "M" Line Swivels.

Prices (approximate)

Return line - - - - - - - - - - - - - - - - $3.50
Main line - - - - - - - - - - - - - - - - - - 4.50

"Gold Standard" Line Swivels.

Prices (approximate)

7/8" for ½" and 5/8" line - - - - - - - - $4.00
1-1/8" for ¾" to 1" " - - - - - - - - 5.00
1-3/8" for 1¼" and larger lines - - - - 6.00

"Warren" Line Swivels.

Prices (approximate)

Light - - - - - - - - $2.50
Medium- - - - - - - - 3.50
Heavy - - - - - - - - 5.00

Cost of Choker Sockets.

Diamond "M" Choker Sockets.

Prices (approximate), either of cast steel or dropped forged pattern.

7/8" - - - - - - -	each	$1.50
1" - - - - - - - -	"	1.75
1-1/8" - - - - - -	"	2.00
1¼"- - - - - - - -	"	2.25
1-3/8" - - - - - -	"	2.75

Cost of Roller and Spools.

Yarding Rollers

The "Porter" Twin Road Roller.

Where the lead plays on a part of the landing, a twin roller may be used to advantage. It is a combination of a vertical and horizontal roller mounted on one frame. Steel frame 18"x22"x24". Bronze bushed manganese steel rollers 8"x12", 2½" case hardened steel shaft, weight complete, 360 lbs.

Approximate price with manganese steel rollers, complete - - $75.00.

The "Hukill" Yarding Spool.

The "Hukill" yarding spool or tree spool is being used very successfully on both yarding and road hauls and is proving superior to the old style rollers, especially in yarding, as it oftentimes may be used in place of a butt chain block, thereby saving the time usually lost in stopping to change the chokers at lead.

Weight - 200 lbs.

Prices (approximate)

	With chilled iron sheaves	With cast steel sheaves	With manganese steel sheaves
14x6½" sheaves	$38.00	$42.50	$45.00
14x9" "	45.00	52.50	57.50

Diamond "M" Manganese Steel Road Roller.

No. 107	8x12x2½" shaft - - - - - - - - - - -	$40.00
No. 108	10x16x2½" " - - - - - - - - - - -	50.00
Extra boxes, each - - - - - - - - - - - - - - -		2.00

OVERHEAD YARDING

General.

With the passing of timber from the lower land, logging operators are confronted with the problem of producing logs from smaller timber, steeper and rougher ground, and at greater distance from spur railroads. With the ordinary ground-yarding system this has meant additional expense. To do the work at the same or less expense, the aim of most logging operators, seems to necessitate a new method. One operator in discussing the cost of transporting the logs from the stump to the landing said: "I believe our yarding item is susceptible of greater revision than any other in our cost of production. It is by far the largest item in the entire classification, and should necessarily be attacked more vigorously with a view to its revision downward."

The overhead cableway may be, and probably is, the solution of the yarding problem. While overhead logging methods have been employed in one way or another for a number of years, they have not been seriously considered or used to any considerable extent in the Northwest until the last four or five years. During this short time the overhead system as

it relates to methods other than the "Lidgerwood" has passed from experimental stages to rather efficient, more-or-less dependable rigs, whose output may be estimated with some degree of certainty. That necessity, combined with the resourcefulness of the Pacific Coast logger, will result in great improvements cannot be questioned.

This system should be of special interest to Forest officers as it is obvious that perfected overhead methods will do more to make National Forest timber accessible than any other improvement in the present method of logging Coast timber that can be foreseen at the present time.

That little can be said of principles and methods is not surprising when one considers the newness of the method and the multiplicity of conditions and factors. The writer has at all times tried to steer clear of generalizations and this is especially true of his treatment of overhead methods.

Five methods are described in the following pages. Two of the methods require special engines, rigging, etc.; the other three are "made-at-home" rigs, requiring no special equipment as a general thing. It must not be understood that they represent the only rigs used on the Coast, for such is not the case. It possibly is true that they have been given the most publicity, and probably represent singly or in combination the best principles so far evolved, as far as yarding and short distance roading are concerned. The use of overhead methods

for long-distance roading is discussed under the heading "Roading".

Lidgerwood Cableway Skidder.

The Lidgerwood cableway skidder is an overhead yarding and loading method. It consists of a cable suspended between trees or poles; known as the head spar, which is placed near the machine, and tail tree, which is placed at the outer edge of the area to be logged. A slack-pulling skidding carriage travels on this cable, being moved forward by the skidding line and backward by the receding line. This carriage also carries the slack-pulling line, which line enables the engine to give out the length of skidding line that is necessary to reach the logs that lay to one side or the other of the overhead cable, and to regulate the distance the log is from the carriage. These lines lead from the carriage through blocks rigged on the poles to their respective drums on the skidding car. The overhead cable is stationary. An auxiliary engine is used to load the logs.

Description of Machine.

The machine used on the Coast is made up of two sets of double engines. The main engine, or what is known as the skidding engine, has 12x12" cylinders and three drums. The back drum, or the one next to the boiler, is known as the skidding line drum. This drum, in connection with the skidding line, hauls the log in. The middle drum is known as the receding or

haulback drum. This drum, in connection with the receding line, is used not only to haul the carriage back but to hold the carriage in place until the log is drawn under the carriage. The receding line drum is provided with interlocking and reversing devices, which permit of the interlocking of the skidding and receding line drums after the ends of the logs have been elevated sufficiently to clear obstructions. These devices result in the receding line being paid out automatically as the skidding line is drawn in. Suitable arrangements are made whereby one drum will not become larger than the other. The third drum from the boiler is the slack-pulling line drum. It has been indicated that this drum in connection with slack-pulling line enables the machine to pay out the length of line that is necessary to reach the logs that lay to one side or the other of the overhead cable, and, with the aid of the engineer, to regulate the distance the load is from the carriage. This drum is set with a tension of 500 pounds so that the slack-pulling line never runs out. The loading engines are 10x10" double cylinders and are supplied with two friction and two clutch drums. The friction drums are used for loading the logs. Only one friction drum, of course, is used at a time. By having two, the loading line can be shifted from one to the other, making it unnecessary for the operator to look over the machine when loading the logs. The engines and frictions are powerful so that heavy logs can be loaded as easily as light ones. The two clutch drums are used

for raising and lowering the main cable, rigging, etc. Steam is furnished from a 64" boiler. The machine is mounted on a steel car which is 22 feet long and 8 feet wide. This car is equipped with a jack at each corner and swivel trucks. With this arrangement it is possible to jack up the car, turn the trucks, lay short pieces of steel rail under the car wheels at right angles to the truck and move the car from the track to a point along the track.

Main Cable Supports.

Trees or poles support the main cable. The spar tree or mast may be a standing tree that happens by accident or design to be standing at a proper place, or a pole erected there. The machine is placed near the head spar. The head spar is from 60 to 80 feet in height from the ground, and from 18 to 30 inches in diameter at the top. If a tree is used the top is cut off to protect the men and machine from falling limbs, or the top. This work is done by a rigger, and takes about one hour. There are six guys on the head spar.

The height of the tail tree depends on the nature of the ground. Sometimes a stump is used; sometimes the tree is 50 feet in height. The height must be sufficient to keep the main cable clear of any obstructions between the two supports. Guys are used on this tree, the cable extending from the tail tree to the ground serving as one.

Operation.

In operation, the outhaul rope draws the carriage out along the main cable. Where a log or logs are to be picked up the tongs or chokers are lowered to the ground by drawing in the slack-pulling line; the free end of the skidding line to which the tongs or chokers are attached is thus freely paid out to the men who hook on the logs. When the tongs, slings or chokers have been fastened to the ends of the logs the skidding rope is drawn in, while the outhaul line and carriage are held fast until the logs are elevated sufficiently at one end to clear obstructions. The skidding and outhaul line drums are then interlocked and as the skidding rope is drawn in, the outhaul line is simultaneously paid out, and the logs are skidded suspended or partly suspended in the air, and dropped at a point where they can be reached with the loading rig. The carriage is then drawn out at high speed by the outhaul line, other logs are attached and the operation is repeated. Where timber is small several logs are brought in at one time.

Loading.

The loading outfit consists of a cable suspended from a head spar tree to a stump on the other side of the track, thus spanning the railroad. This cable supports a loading carriage, guyed directly over the track. The loading line passes from its drum on the loading engine through a block on the head spar tree and thence through a second block depending from the

loading carriage, and to the end of this line is attached the loading tongs. The logs brought in by the skidder are grappled by the loading tongs, drawn from under the main cable up to the car, where they are hoisted clear, and deposited upon the car. Skidding and loading are carried on independently at the same time.

Lines.

The following is the length and diameter of lines used with a "Lidgerwood" working in rough, steep country and small timber:

2 main cables; $1\frac{1}{4}$" in diameter, 900' in length.

2 main cable extensions; $1\frac{1}{4}$" in diameter, 900' in length.

Loading guys; 1-1/8" in diameter, 800' in length.

Skidding line; 7/8" in diameter, 1100' in length.

Skidding line extension; 7/8" in diameter, 150' in length.

Receding line; $\frac{3}{4}$" in diameter, 1800' in length.

Loading hoist; $\frac{3}{4}$" in diameter, 250' in length.

Main cable extension block; 5/8" in diameter, 400' in length.

Grass line; 7/16" in diameter, 1800' in length.

Slack-pulling line; 3/8" in diameter, 1100' in length.

Guy line, may be old; 7/8" in diameter, 2200' in length.

Life of Lines.

One operator in discussing the life of lines made the following statement: "Lines last well. The skidding line lasted just about a year; the main cables have been in use a little

over a year and appear to be sound. We estimate they are 50 per cent sound." These lines were of the following sizes: Skidding line, 7/8"; main cables, 1¼". The above statement was the result of one year's experience with the Lidgerwood. During this year the machine worked 227½ days and put in 9,164,900 feet. This would mean an output of about nine million feet for the skidding line and the same amount for a main cable, as two were used during the year. The machine was working in very rough steep country, and small timber.

The same operator, one year later, in discussing logging lines, etc., made the following statement: "The cost per M feet when using the overhead cable-way system (he had the 'Lidgerwood' in mind) is about a standoff with the yarding and loading system (ground yarding)." At another time he stated: "In the system mostly used at present - yarding directly to the track and loading - the average cost is about 12½ cents per M feet." This suggests that his experience with the "Lidgerwood" showed the cost of the lines to be in the neighborhood of 12 cents.

The makers of the "Lidgerwood" contend that since the blocks and wire rope are operated clear of the ground the cost of these is much less than with ground yarding, "being, in fact, normally about 20 per cent of that of the ordinary ground system".

Blocks.

In addition to the saddle block which carries the main cable there are five blocks used. They are self-oiling. The large blocks hold about a quart of oil, while the smaller ones hold about a pint.

Carriage.

The carriage used is what is known as the multiplying, slack-pulling carriage. The makers claim that by using this type of carriage the power of the machine is multiplied in the carriage itself. The carriage is automatic and is built entirely of steel.

Area Logged on Each Run.

The area logged on each run is from 100 to 150 feet wide at the tail tree and tapers to a point at the head tree. The riggers should, of course, keep ahead of the skidding proper, and this is regulated by the number of riggers employed.

Changing Lines.

The tail tree is changed for each run. Two main cables are used. While one is being operated the rigging crew is at work getting the other in place on the next run. When all the timber adjacent to one main cable has been logged, that cable is dropped by the lifting and lowering drum, disconnected from the main cable heel block, and taken out of the carriage. The other main cable, already placed by the riggers, is placed in the carriage, connected, and tightened up. This takes from

30 to 45 minutes.

The next tail tree is now selected. A light changing line provided for the purpose is drawn out from the head spar tree on the new run up to and around the newly selected tail tree, and thence to the tail tree that has just been deserted. It is made fast to the main cable left lying upon the ground on the run last logged, and, by means of a drum on the engine, the changing line is drawn in, thus dragging the main cable entirely around the newly selected tail tree, to a position between the head and tail trees on the new run ready to be connected up when required.

Area Logged at One Setting.

The area of the average tract logged by the "Lidgerwood" at one setting is about 40 acres. This required hauling the logs from a maximum distance of 930 feet.

Moving Machines.

The makers of the machine in a prospectus state that the "changing of the skidding engine from one setting to another consumes from two to six hours, depending on conditions. It is questionable whether it is often or ever done in this time.

One operator who employs one of these machines discussed the time required to move from one setting to another as follows:

"If a duplicate set of rigging is used the time consumed in moving the machine from one setting to another would

be about from one-half to three-fourths of a day; in case a single rigging is used the time of moving would be from one day to a day and a quarter."

Another operator stated that it took on an average of two days to move the machine from one setting to the other.

The loss of time in moving is not considerable when compared with the loss of time in moving donkey yarders, as the machine does not have to be moved after once set and the operation of skidding the logs rotates entirely around the head tree. Then, too, the skidding distance is possibly greater than the average ground yarding distance.

Putting up Rigging on Head Spar.

After the top is cut from the head tree the rigging is put up. This consumes from three to four hours, depending on the number of riggers and their ability.

Output.

One operator who is using one "Lidgerwood" machine discussed the output as follows:

"As to the output, we are not in a position to tell what the system will do in a good show. We have operated on very rough, steep ground and small timber. From May 1 to May 1 we worked 227½ days, being shut down for the month of July and having the usual Christmas shut-down, and put in 9,164,900 feet, a daily average of a little over 40,000 feet. This is not a large average, but owing to the conditions think it better

than we could have done by any other method. Our largest day was 84,000 feet, and our best monthly average was made last February, being 53,000 feet per day. In these averages the time moving has been counted in as working days."

Advantages.

It may be that fewer miles of railroad have to be built in connecting the "Lidgerwood" cableway skidders than with ordinary ground yarding donkey. One operator discussed the point as follows:

"We have found that it is not economical to attempt to yard with a donkey engine over 600 feet. To keep within this limit it is necessary to locate our railroad spurs 880 feet apart, or three branches must be built through each 160-acre tract. Inasmuch as the 'Lidgerwood' covers 40 acres at a setting, it is necessary to build only two spurs to each 160 acres, or in other words, a given tract of timber can be logged with a 'Lidgerwood' with two-thirds the length of track which would be required to advantageously use the donkey engines. Therefore, to be more exact and in order to estimate in full the saving which may be effected by using the 'Lidgerwood', one should take into consideration the cost of his railroad construction and consider that one-third of that expense may also be saved by the use of the Lidgerwood skidder."

Inasmuch as the logs are skidded entirely or partly in the air, they gather less sand, grit or rocks than those

skidded over the ground by the ordinary donkey yarder.

The "Lidgerwood" can possibly handle smaller timber at less expense than the ground yarding engine. The machine is fast and the logs being suspended in the air seldom hang up as is frequently the case with ground skidding. This possibly results in a larger number of turns in a day with the "Lidgerwood" than with the ground yarder.

No landings have to be built.

Disadvantages.

One of the most noticeable deficiencies of the "Lidgerwood" is in the loading. Logs can be skidded to the track faster than they can be loaded.

Another disadvantage is that men do not like to work around the machine.

Of course, another disadvantage is the cost of the rig.

Comparison of the Cost of Logging With the Lidgerwood Overhead Rig and Ground Yarders.

One operator who is using Lidgerwoods and ground yarding donkeys discussed the relative cost of logging by the two methods as follows:

"We are now using in our logging operation two "Lidgerwood machines and from two to four donkeys. Our first Lidgerwood was purchased in April, 1909. The second was installed one year later. At the end of the first year our annual statement showed that the cost of loaded logs in cars by the skidder was 64 per

Skidding Crew.

1 Skidder leverman
1 Fireman
1 Unhooker
1 Signal punk
2 or 3 Tongmen or chokermen

Rigging Crew.

1 Head rigger
1 Assistant rigger
1 Helper

Loading Crew.

1 Loader leverman
2 Loading men.

This is the crew as enumerated in the prospectus of the Lidgerwood Mfg. Co. One operator working in rough, steep ground and small timber uses the following crew:

1 Skidding leverman
1 Loading "
1 Fireman
1 Wood cutter
3 Loaders
4 Riggers
2 Tongmen or chokermen
1 Unhooker
1 Whistle punk

Another operator working in good ground and timber that averages possibly 1000 feet in volume to the log uses the following crew:

1 Skidding leverman
1 Loading "
1 Fireman
3 Loaders
1 Unhooker
1 Whistle punk
4 Chokermen
5 Riggers

Coal was used as fuel.

Another operator working in good ground and timber that averaged about 400 feet to the log uses the following crew:

1 Skidding leverman
1 Loading "
1 Fireman
1 Wood cutter
3 Chokermen
2 Unhookers
3 Loaders
1 Whistle punk
5 Riggers

The average output per machine per day was about 70 M feet.

Another operator working in good ground and small timber uses the following crew:

1 Skidder leverman
1 Loader "
1 Fireman
1 Wood cutter
3 Chokermen
1 Whistle punk
1 Unhooker
3 Loaders
4 Riggers

Wages.

Head hooker or head chokerman - -	$4.50	to	$5.00	per	day
Chokermen - - - - - - - - - - - - - -	3.00	to	3.25	"	"
Unhooker- - - - - - - - - - - - - - -	3.00	to	3.25	"	"
Whistle punk- - - - - - - - - - - - -	2.75	to	3.00	"	"
Fireman - - - - - - - - - - - - - - -	3.00			"	"
Wood cutter - - - - - - - - - - - - -	2.75	to	3.00	"	"
Skidding engineer - - - - - - - - - -	4.00	to	4.50	"	"
Loading " - - - - - - - - - -	3.25	to	3.50	"	"
Head loader - - - - - - - - - - - - -	4.00	to	4.50	"	"
Second loaders- - - - - - - - - - - -	3.25	to	3.50	"	"
Head rigger - - - - - - - - - - - - -	4.00	to	4.50	"	"
Second " - - - - - - - - - - - - - -	3.50			"	"
Assistant riggers - - - - - - - - - -	3.00			"	"

First Overhead System on the Coast.

The first overhead system was possibly used by the Kalama Logging Company at Kalama, Washington in 1905. In speaking of this rig the operator said:

"The ground was a very steep hill, dropping to the Kalama River. It was 900 feet from the bottom of the river to the top of the hill. The elevation was about 600 feet. This was about two-thirds pitch. The ground was so steep it was all a man could do to climb up it. The timber was small-sized fir, running from 600 to 1500 feet to the log. We cut up to 40 feet. The ground was so steep we could not pull the logs down, and there was not enough water in the river to permit of using a chute. We took our ordinary 8½x10" Willamette engine and rigged a double brake on the trip, just twice the width of the ordinary brake. We used 1500 feet of 5/8" line for the trip or hold-back. The standing line was 1" plow steel.

We made the main line fast to a stump on the opposite side of the river, carried it to the top of the hill, passing it through a block fastened on a properly guyed tree about 60 feet from the ground. A 12" line was reeved into the end of the main line. A 7/8" line ran from the main drum through the block on the end of the main line, and thence back around a stump, providing a purchase for raising the main line. The trip line was placed 150 feet to one side of the main line, running through blocks to the carriage. In yarding a log, say 150 feet from the main line, the trip line would pull the carriage and main line over to the log, permitting the log to be hooked on. At a signal to the engineer the slack was taken out of the main line by reeling the rope on the drum and elevating the log; the trip line controlling the log. It took about 30 seconds to hoist the log and drop it into the river. When the bottom was reached, upon a signal the engineer slacked the main line, lowering the log to the river to be unhooked. The log being released, the engineer took the slack out of the main line and started his trip line back, carrying the block to the next log, repeating the operation as often as desired. The leads were changed to accomodate the different positions of the log."

"Five men were necessary to operate the system: engineer, fireman, hook tender, rigging rustler and unhooker."

"The cost of yarding logs by this system was considerably less than ground yarding. In our particular case the

costs of falling and bucking were high on account of the steepness of the ground. Taking it altogether, we logged the steep ground about as cheaply as we could have done on moderately level ground with the ordinary ground yarding system."

The rig constituted an overhead snubbing device as it could be operated only on ground steep enough to cause gravity to take the logs in. It will be noted that the machine set at the top of the hill. The operator was of the opinion that it would have been better to have set the machine at the river level on the side opposite the timber, as this would have made it possible for the engineer to have a full view of the entire operation at all times instead of having to depend upon the tension of the line to guide him in his control of the engine.

Gravity Cable System.

This rig which is much the same as the one just described, is possibly the second overhead system used on the Coast. It is described by the operator as follows:

"Show".

"Out timber was located on a bench about 800 feet above the mill. It was small, running about four logs to the thousand. We had tried to chute the logs, but the loss due to breakage was too great, and this had to be abandoned. The rise from the mill to the timber was precipitous, an elevation of 800 feet being attained in 1500 feet, making nearly half-pitch. As stated before, our original plan was to chute the logs down

the mountain, a distance of 1000 feet, and then yard them into the pond, a distance of 500 feet."

Rigging.

Fifteen hundred feet of 1-1/8" line was used for a standing line. This line was made fast to a tree standing on the bench at about 75 feet from the ground. This tree was securely guyed. In order to overcome the necessity of handling direct with the engine the long, heavy cable and at the same time giving an easy and convenient means of taking up and paying out the slack, a purchase block with a 16" sheave was spliced onto the main cable. A 1" line was passed through the purchase block, one end leading to the main drum of the engine and the other end made fast to a stump. The purchase block was located about 75 feet equidistant from the engine and the stump, and allowed for about 30 feet of slack. The taking up of the slack on the purchase and main line by the donkey was the means employed for lifting the load of logs from the ground. It required but a few revolutions of the engine to accomplish this. The trip line was used as an ordinary trip line, passing through several blocks and made fast to the carrying block at one end, while the other end was attached to the trip drum on the engine. In order to bring the traveling or carrying block close to the logs when the rig was being used as a roading device, two ordinary corrugated tree rollers were located on the deck landing about four feet apart. The trip line passed over one

and under the other, with the result that the carrying block and the line on which it ran were brought close to the ground where the landing man was able to pass his choker around the turn promptly. To the traveling block or carriage is attached a swivel and hook. Then attached below the hook again is a butt chain about seven feet long, to which the wire rope choker is attached. This chain is used to give sufficient weight to the empty carrying block upon its return journey, so it will ride perpendicularly. The weight of the chain also aids in the automatic unhooking of the two hooks, the one on the block and the other on the choker, when the log reaches the pond. Both hooks are made just as shallow as we dared to make them, and with the natural spring in the wire rope, and the direct downward pull, we have never had any trouble through the hooks not automatically releasing. By having the choker fastened to the chain the choker was never left in the pond, but was returned to the rollway, and if a longer or stouter choker was required, this hook could be unfastened quickly and another choker substituted. The hook is in two sections and fastened to a small ring in the choker."

Engine.

"The engine we used was the ordinary Willamette engine, 9½x11", provided with an auxiliary brake on the trip drum to assist in controlling the speed of the incoming load. The auziliary brake was made by drilling through the flange of the

trip drum on the engineer's side and bolting 4" hardwood blocks on the inside of the drum. Then we used a 4" steel strap to act as a brake on these blocks and coupled to the brake rod and levers the same as the ordinary brake on the engine. Thus the auxiliary brake worked simultaneously with the regular brake."

Operation.

"It will be noted that it is a gravity system, with the engine placed at the bottom of the hill. It is simple, effective and speedy, and can be used with any size of logs by simply altering the length of the choker, of which we kept a number of different lengths and sizes. Should the engineer find at any time that he cannot control his load and that it is coming too fast for him, or should the trip rope break, there is still no danger, for if the purchase line is slackened the load will strike the ground and naturally come to a standstill. On one occasion we had the trip rope break, and the load was immediately dropped to the ground and no damage was done. It is essential that a sufficient grade be attained in order to bring the logs in quickly from the point of loading to point of destination. The engine had to make only five or six revolutions to pick up the load and take it off the rollway."

Crew.

"Three men operated the rig; that is, when roading."

Output.

"Where the logs were small we would take from five

and six to fifteen hundred feet. I have hauled 36,000 feet in three hours, 12,000 feet per hour; 30 M to 45 M feet a day was all we required, but we made a test one day to test the thing out."

Life of Rigging.

"One great advantage which this system has is the fact that all the cables and rigging are off the ground and the constant wear and tear in contact with the ground is absolutely eliminated, thus adding very considerably to the length of life of the rigging. During two years we handled eight million over the main cable. We then took the line down and used it for a yarding line for another season before it was worn out."

McFarlane Sky Line Logging System.

The rig is made and sold by the Willamette Iron & Steel Works of Portland, Oregon. It is described by the company as "a system of yarding through the air instead of on the ground. It differs from overhead cable systems in that no slack line is drawn from the carriage, but the main line upon which the carriage travels is raised and lowered in its operation. The system can be used on any kind of ground, but it is especially adapted to steep hillsides."

Rigging.

The rigging consists of a main cable, suspended between two trees, a head tree and a tail tree. Upon this line the carriage travels. Two lines only are required to operate the

carriage - one to haul it in and the other to take it back. The main line passes through a block on the head tree, and over a special shoe on the tail tree, thence made fast to a stump below. The haul-in line is fastened to the front of the carriage and passes through a block on the head tree to the haul-in drum. The haul-back line which returns the carriage passes through a series of yarding blocks to the trip drum of the engine.

The size of the lines used in operating this system varies with the conditions. In the ordinary operation $1\frac{1}{4}$" to $1\frac{3}{4}$" main line and $\frac{3}{4}$" haul-back line are used.

When the sky line is $1\frac{1}{2}$" or less, it will usually lead direct to the main drum of the engine. If the length of span requires $1\frac{3}{4}$" or larger sky line, it will be necessary to use a single block on the end of the line, thus doubling the pull of the engine on this line.

Operation.

The haul-back line hauls the carriage out along the main line to the point where the log is to be hooked on. Then the main line is slacked sufficiently to lower the carriage to the ground. The choker is hooked to the carriage and the main line tightened again, until the load is raised free of obstruction. Powerful brakes on the main drum hold the line taut, while the carriage with its load is pulled in. The load is unhooked, carriage returned, and the operation repeated.

When operating on steep ground, the haul-in line is not required, as the carriage will run in by gravity. Powerful brakes are provided on the trip drum to control the load in its descent.

Changing Lines.

One head tree is all that is required at each setting of the engine. The tail tree is changed each time a strip is logged. The new tail tree is selected and guyed before the old one is deserted. When the change is made, the lines are drawn to the head tree from the old tail tree, and with the straw line the trip line is hauled out to the new tail tree. The trip line is then used to haul out the main line, which is made fast.

Roading.

The rig may be used if desired to lower logs from an otherwise inacessible plateau; a railroad, ordinary donkey or other means being used to bring the logs to the tail tree, from where they are lowered down the descent in a similar manner to the method used in yarding.

Engine.

"The engine used is a 4-drum donkey engine. The main drum is driven through a compound train of gears by an internal gear, so that it revolves in the same direction as the trip drum. All drums rowate so as to take the lead of the line on top. The trip drum is a high-speed drum, which insures a quick return of the carriage. In front of these two drums are

located the haul-in drum and the straw line drum. The two principal drums are equipped with steam friction, the throttles of which are banked in front of the engineer immediately below the main throttle. The brake operating levers are mounted within easy reach of the engineer's left hand. The main and trip drums are each provided with powerful steam-operated brakes. The engineer controls the pressure exerted by the brake through the valve of the brake cylinder. The operating lever is connected to both the valve stem and crosshead. When the lever is moved to any position opening the valve, the travel of the crosshead automatically closes the valve, when the desired tension is reached. This forms a flexible control. The boiler is 72" in diameter, with oblong fire box."

The following is taken from a report dealing with the McFarlane rig by a Forest officer:

"From noon on the 17th day to noon on the 18th, nine cars of 7000 feet each were yarded and loaded. Yarding distance, 900 to 1100 feet. The output for the first four days was 237,000 feet, or an average of 59,000 feet per day. The extreme yarding distance was 1500 feet. The crew on this kind of an operation is larger, and the duties differ somewhat from that of a "ground" yarding crew. The "hooker-on" corresponds to the hook tender in ground logging; he plans out the location of the head and tail trees and where lead and haulback blocks shall be set. The "unhooker" corresponds to the "chaser" in

ground logging. The head climber has charge of setting all rigging as planned by the "hooker-on", and his crew works ahead of the logging crew preparing the tail tree to be used next. The remainder of the crew are the same as in ground logging. The time required to change all lines from one tail tree to another is two hours. A strip 300 feet wide, 150 feet on each side of the lines, is logged from one tail tree. A total of 160 acres can be logged from one head tree, using 1500 feet of line between head and tail trees, and turning donkey engine after the first 80 acres have been logged."

Yarding Crew.

1 Head hooker	$4.50	per	day	$4.50
2 Chokermen	3.25	"	"	6.50
1 Unhooker	3.25	"	"	3.25
1 Signalman	3.00	"	"	3.00
1 Engineer	4.00	"	"	4.00
1 Fireman	3.00	"	"	3.00
1 Woodbucker	3.00	"	"	3.00
				$27.25

Loading Crew.

1 Fireman	$2.75	per	day	
1 Engineer	3.25	"	"	
1 Head loader	4.50	"	"	
1 Second loader	3.50	"	"	
1 Third loader	3.00	"	"	
				$17.00

Rigging Crew.

1 Head climber	$4.00	per	day	$4.00
1 Second climber	3.50	"	"	3.50
3 Helpers	3.00	"	"	9.00
				$16.50

Total cost yarding, loading and rigging crews, per day $60.75

"On the basis of 59,000 feet per day the labor cost of yarding and loading would be $1.05 per M feet. Yarding with ordinary donkeys, the labor cost on ground and timber of like character at the same camp ran $1.50 to $1.60 per M feet."

Cable.

"The amount and size of cable vary with kind and size of timber and length of haul. This operation used 1800 feet of 1½", 6x19 plow steel cable, for the standing line; 2000 feet of 7/8", 6x19 plow steel for haul-in line; 4000 feet of 7/8", 6x19 plow steel for haul-back line; and 4000 feet of 3/8", 6x19 plow steel for straw line. Chokers were made from 1-1/8", 8-strand plow steel cable as it is more pliable than 6-strand."

"The guys vary with the operation, but six are always used on the head tree and five on the tail tree. On this operation there are six 1½" guys, 250 feet long, on the head tree; and two 1" guys, 200 feet long, two 1" guys, 250 feet long, and one 1½" guy, 250 feet long, on the tail tree. There are two sets of guys for tail tree, one in use and the other being set up. The life of cables is given at one year, but will vary with conditions."

Blocks.

The blocks furnished with the machine are all that are required in operation and are as follows:

1 24" bull block
3 heavy moving blocks

2 lead blocks
2 18" trip or haulback blocks
2 14" " " " "
4 12" " " " "
2 shoes for standing line to hang on tail tree.

"When the present setting is logged off, the outfit will be used in a roading operation. The sky line will be 2500 feet in length and yarders will yard to foot of tail tree, and the sky line will handle the logs to railroad. The camp superintendent was of the opinion that the sky line would take away from two yarders. By roading in this manner no road or chute roads will be necessary."

"The following is taken from the camp report on sky line operations during April, 1913: Yarded and loaded during April, 1,664,000 feet at a labor cost of $1.06 per M feet. The maximum yarding distance was 1500 feet, and the character of ground varied from straight down-hill to alongside-hill. The slope was 45° on a portion of the area."

An operator who is using the McFarlane rig stated: "We can put in 75,000 to 100,000 feet per day. If we did not have the sky line we would put in only about one-third of this amount. The rig will log 150 to 200 feet on each side of the sky line. The carriage runs back at the rate of 600 feet per minute. A log can be brought in at a distance of 1200 feet after it is hooked on in about 70 seconds." This operator was working in large timber and steep ground. The grade of the ground ranged from 50 to 85 per cent. In places it was

steeper than this, and the task of logging was increased by the presence of rock outcrops. Logs containing as much as 6000 feet were successfully handled with the rig. The writer visited this operation and he thinks the output over a considerable period of time never averaged as much as the above figures. When he was there the rig was putting in from 50 to 60 M feet per day.

Output.

Anyone who watches this rig will form an idea of its capacity. It is thought that no one would feel sure that he was right. The rig has not been thoroughly tested. It possibly will average from 50 to 75 M feet per day.

Cost.

The engine costs about $8,600 f.o.b. Portland. The makers will install rig, guaranteeing a certain output or labor cost per M feet for a stated period, for $12,000. This figure includes the engine, blocks, lines, etc.

Depreciation.

No one knows what the efficient life of these machines will be. It may be safe to figure the life at a little higher figure than the ground yarder, say about ten years.

North Bend Flying Machine.

This overhead rig was first used by the North Bend Lumber Company, North Bend, Washington. It is now used for both yarding and roading logs. Its most commendable features

are its simplicity and economy of installation. In describing this system the writer has, for the most part, used extracts from an address dealing with the rig, by one of the operators, taking the liberty to arrange the matter as he thought best.

Aerial Line.

"The aerial or carriage line is permanently suspended from a spar tree at the landing to a tail tree at the back of the "show". This line consists of 1500 feet of 1¼" or 1-3/8" wire, varying in diameter with the size of the timber to be logged. In this connection it may be said that we believe 1¼" wire is sufficiently strong for logs scaling 2000 feet; and 1-3/8" wire for logs scaling 2000 to 4000 feet. The 1¼" line may be converted into chokers after it has become worn somewhat and rendered unsafe for overhead use. One end of this line is first made fast to a stump or tree directly in the rear of the tail tree, the other end passing through bull blocks hung in the tail tree and head tree respectively, and tightened by means of a block and line used for this purpose only. This tightening line is only 350 feet in length, and is made fast to two stumps, passing through a block attached to the aerial line, thus involving two anchors rather than one."

"Two aerial lines and extra bull blocks are employed which greatly facilitates changing from one tail tree to another."

Other Lines Used.

"Fifteen hundred feet of 1-1/8" line is carried on the main drum as a yarding line, 3000 feet of 9/16" wire for haul-back line and 2,500 feet of 3/8" wire for straw line."

"The spar tree is reinforced with six 1-1/8" guy wire, each from 200 to 400 feet in length; while the tail tree has only one guy line other than the aerial line which forms a support in itself."

Life of Lines.

"The wear on the yarding line is negligible except on that portion which plays on the 12" block in yarding the log. It may, therefore, appear that a 1-1/8" diameter line is excessive for this purpose, but we believe it is more economical in the long run than a smaller one, inasmuch as it is fit for chokers following its yarding service."

"The strain on the haul-back is, however, greater than in ordinary service, due to the necessity for deflecting the yarding line and block at right angles with the aerial line in picking up logs."

"Our records show a yarding line in this service with a credit of nine million feet and still retaining 50 per cent of its life when discarded for chokers. The haul-back is not used for the purpose of snubbing the logs, and is handled in the same manner as in the ground yarding operation."

Carriage.

"The carriage is constructed of ¾" boiler plate reinforced with 1" straps and includes three 5x14" manganese sheaves; two of which operate on the aerial line. The third sheave, while not used now, was originally intended to accomodate the yarding line. Its cost complete is about $105.

Engine.

".... an ordinary two-drum 11x13" 'Willamette' yarder with straw drum, ... with a gear ratio of thirteen to one for yarding the logs; which, needless to say, is slow and exceedingly heavy. Inasmuch as the power requirements are, comparatively speaking, negligible, it is obvious that this item may well be sacrificed for speed, and therefore, we believe that far better results would be obtained by employing, say, a 10x11 donkey, geared in the neighborhood of six and one-half to one. This would double the speed."

Yarding Distance.

"We found that while it is practicable to operate a distance of 1500 feet, the best results are, nevertheless, obtained at approximately 1000 feet, especially after a crew of men becomes familiar with the method of changing from one tail tree to another."

Tail Trees - Distance Apart. (300 to 400 feet apart)

"We find it economical to yard logs lying from 150 to 200 feet on either side of the sky line. Farther than

this the strain on equipment due to the logs lodging behind stumps and the resulting danger of uprooting the tail tree, are features which outbalance the slight gain in additional territory covered at one setting."

Changing Lines.

"Since two aerial lines and extra bull blocks are employed, which greatly facilitate changing from one tail tree to another, the time involved in these changes averages about three hours."

Most Distinctive Feature.

"The most distinctive feature of the rig, no doubt, is the method involved in engaging the yarding line to the carriage and yarding the log. Through the different ramifications of this feature, one great trouble has been our inability to secure sufficient slack when and where it was needed, as for instance, when the logs were deposited at the landing, the chaser experienced difficulty many times in disengaging the chokers. To obviate this defect, we have adopted the present method of engaging the yarding line to the carriage which is extremely simple.

"From the donkey the yarding line is passed through a bull block high on the spar tree, and is attached to a clevice at the bottom of the carriage; at the same time passing through an ordinary 12" yarding block which is used for raising the logs.

"To the clevice or goose-neck of this block is attached a ring carrying two butt lines, to each of which two chokers may be attached, making it possible to accomodate four chokers in all. To the last mentioned ring is attached the haul-back. The strain of lifting the log is equally divided between the aerial line and the spar tree. This feature has been quite thoroughly tried out and has proven quite satisfactory to date. We first sought to lift the log from the ground and lock it to the carriage, but we found such a method unnecessarily cumbersome, and discarded it. We later passed the yarding line through the lower sheave of the carriage, attaching the end to the clevice at the bottom, lifting the logs by a block rendered in the bight so formed, but did not lock them to the carriage. Both of these methods brought the entire strain upon the aerial line, which is a very volnerable factor of any overhead system."

Output.

".... Therefore, I shall select the month of August just passed, mentioning the results obtained, with the explanation that I consider them about average:

		Per day
Number of days worked - - - -	26	
" of logs yarded - - - -	3720	143
Total scale, feet - - - - - - -	1499250	57,660
Average per log, feet - - - -	403	
Number of cars loaded - - - -	298	11½

Average per car, feet - - - - 5030

"Ground was slightly broken but, on the average, good."

"For the first six months of 1913, during which we logged almost entirely by this method, our average scale per man, exclusive of railroad men and cooks, was 1517 feet."

Loading.

"We construct what is known as the jump-up landing, and use a gin pole and crotch line. To compel the loading crew to select their logs from beneath the aerial line necessitates their working at a great disadvantage and a consequent loss. A third man in the crew is quite desirable. Logs from the first two or three roads on both sides of the landing may be deposited on the landing, parallel to the car by the aerial line, but as each succeeding road forms a greater angle with the track this is impossible and the logs accumulate in a huge pile resembline jack-straws, beneath the aerial line. We, therefore, at such time bring into play a third donkey for the purpose of swinging these logs into line on the landing. In the abstract this would indicate a prodigal employment of machines, but the results in our case have justified such an outlay. The third donkey involves the employment of only two additional men, an engineer and fireman, as the chaser attending this engine supplants the third loader. When we first employed this method our landing facilities were very deficient,

causing endless delay to the loaders, and by using the third donkey we increased our daily output from 9 to 14 cars per day, with an outlay of only $6.50 additional."

Expense of Installation.

"Any operation supplied with the ordinary donkey engine and rigging may become fully equipped for this system of aerial logging with an expenditure of not to exceed $1500."

Adaptability, Timber.

".... While we were handling logs scaling as high as 5,000 feet in the early stages of our experiments, we have not, with our present device, yarded over 3,600 feet at one time."

Adaptability, Ground.

"We have employed this system on steep ground, side hills, yarding logs both up and down, over hog backs and through gulches, and in most cases the force of gravity operates as a brake to such an extent as to automatically control the log. In extremely precipitous country, however, more or less trouble is experienced with logs running out of the chokers." (This is one of the major faults with the rig.)

Crew and Wages.

The following is taken from a Forest officer's report on this rig: "The crew consists of 21 men as follows: This crew will be reduced - 1 engineer and 1 fireman -

Skidding	Wages per day
1 Hooktender - - - - - - - - - -	$5.00
3 Chokermen - - - - - - - - - -	10.00

Skidding		Wages per day	
1	Signal man - - - - - - - - - -	$2.75	
1	Chaser - - - - - - - - - - - -	3.50	
1	Rigger - - - - - - - - - - - -	4.50	
2	Swampers - - - - - - - - - - -	5.50	
2	Engineers- - - - - - - - - - -	7.00	
2	Firemen- - - - - - - - - - - -	5.50	
2	Woodbuckers- - - - - - - - - -	6.00	
			$49.75

Loading			
1	Head loader- - - - - - - - - -	$5.50	
1	Second loader- - - - - - - - -	3.50	
1	Third loader - - - - - - - - -	3.00	
1	Engineer - - - - - - - - - - -	3.00	
			$15.00
			$64.75
	Pumpman - - - - - - - - - - - - -		3.00
	Foreman - - - - - - - - - - - - -		7.00
			$74.75

"The camp output for one month was 1,898,000 feet, or an average of 73,000 feet per day. This is an average labor cost of $1.03 per M feet. The "sky line", working at a maximum distance of 800 feet down-hill, put in 1,600,000 feet, while a ground yarder, operating on a better "show" at a maximum yarding distance of 500 feet, put in 750,000 feet in the same length of time. The location of the donkeys makes it necessary to pump water; this takes one man's time."

"The fallers cut everything including snags, leaving tail trees only. The small understory stand is all cut by the swampers who work ahead of the yarding crew."

Roading.

"The rig may be used for roading as well as for yarding."

GROUND ROADING

General.

It is generally accepted that the best practice in logging on the Coast is, so far as possible, to build railroad spurs in such a manner that the logs may be yarded directly to the landing. Occasions arise when it becomes necessary because of the location or amount of the timber to do what has been termed "roading". That is, instead of accomplishing the haul from the stump to the landing with one machine set at the landing, two or more machines working tandem are used. The haul from the first machine to the machine set at the landing may be called roading.

The expression "roading" does not always mean the same thing. Quite often two or more machines will be used to transport the logs from the stump to the landing, and the expression "roading" will not be used in connection with any of the steps in the operation. The operator may refer to the method as "double hauling" or "double yarding" when two machines are used, and "triple hauling" when more than three machines are used. Then, too, two or three machines may be used and the operator will refer to the method as "yarding". The expressions "long-haul" and "short-haul" roading are used. Under this heading the writer will discuss only long-haul roading. Short-haul roading is discussed under the heading "ground-yarding".

In the past it was the common practice in Oregon and Washington to road logs long distances to the railroad. At the present time, however, this method is not used to any extent, as the railroad in conjunction with the geared locomotive has proved to be a better method. And with the incline and overhead machines perfected, long-haul ground roading will probably be used but little in the future. Of course, on some "shows" it will no doubt be used.

Machine.

This haul is usually accomplished with a road engine. Sometimes, of course, when the haul is short, the ordinary yarding engine is used. Long-haul road engines can handle a mile and one-half of 1½" line.

Table of Sizes of Two Long-Haul Roaders.

Size	Speed	Weight
12x14"	(Main line, 420 ft. per min. (Trip line, 530 " " "	50,000 lbs.
14x14"	(Main line, 515 ft. per min. (Trip line, 700 " " "	60,000 "

Prices, Road Engines (March, 1913)

"Willamette" (f.o.b. Portland)

	Cylinder	Price	Weight in lbs.
Long-haul	12x14"	$4,650	46,000
	14x14"	5,450	58,000
	Oblong boiler, 72"	$5,700	
	" " 76"	5,775	
Three-drum	12x14"	$4,950	

"Washington" (f.o.b. Seattle)

Cylinder	Price	Weight in lbs.
14x14"	$3,450	36,300
12x12"	3,500	36,500
13x14"	4,350	45,200

Life, Road Engines.

See "Ground Yarding".

Life of Lines.

The main line will probably take out 10,000,000 feet; the trip line, twice as much.

Pole or Chute Roads.

While it is sometimes economical to road logs 2,000 feet or more over a dirt road, it is customary to build pole roads - generally of the three-pole type. Operators first used skid roads, and in some camps in California part of the road is still built of skids. It is the understanding of the writer that the operators in Oregon and Washington found the pole road more satisfactory.

Location.

The roads are loacted in much the same was as railroads. They must be so located as to reach the maximum amount of timber, and to facilitate yarding. Needless to say, a straight road is most satisfactory. Favorable grades up to the point where the logs will run is an advantage. Adverse grades, of course, should be avoided if possible.

Cost of Constructing.

A logging superintendent in discussing roading made the following statement in 1910: "It is ideal, of course, to yard every stick of timber directly to the railroad and load it on the car, but that is out of the question in a good many cases and other methods have to be resorted to in the way of pole roads and chutes."

"The method of building pole roads or chutes and the cost of the same vary a great deal and are built a great many times where there is no need of them because the logs could have been logged better and cheaper had a railroad been laid into the country; but that doenn't enter into the question here under discussion as we have already decided that it must be done.

"Two and three-log pole road should not cost to exceed 27½ cents per foot and be built in such a way that it would require no care.

"Running chute will cost 55 cents per foot for large fir timber if built to give entire satisfaction. A running chute is the most satisfactory where the logs go into a pond and are loaded on the car from the water. The dam of this kind will cost $1600. Another advantage in having a dam, aside from the fact that it saves the timber from breaking, is the fact that in case anything happens to delay the operation of the railroad, you have some place to store a few logs."

"Mr Clarence Powell, woods superintendent of the Falls City Lumber Co., built 1000 feet of two-pole road for $250.75 with two engines, one placed at each end of the proposed road and building toward each other. The country was a steep side-hill with two small canyons over which two spans of 100 feet each were built. The time required was six working days - from June 5 to June 10, 1908, inclusive, or at a cost of approximately 25 cents per linear foot. This cost does not include wear and tear on machinery, line, rigging, etc., or timber used."

The cost of pole roads varies. The cost probably ranges between 25 and 50 cents, depending on the show. Sometimes they cost more than this.

Crew.

A road donkey crew is usually made up of an engineer, fireman, woodbreaker, chaser and grab man. When the output exceeds 75 M feet per day, two grab men may be employed. For wages paid, see "Ground Yarding".

Output and Roading Distance.

The following is a statement by a logging engineer: "The average length of haul of a road engine is generally 3,000 feet, and at this distance the machine should be large enough to take care of the output of two yarders, and where the distance exceeds this, would advise the placing of a swing donkey in the road.

"The average cost of labor and deterioration of machinery and rigging on a road will run about $32.50 per day, or if the road engine is taking care of the output of two yarders you will have the following cost for roading different sizes of timber:

Timber	averaging	2,000	ft.	per	log,	180	M	per	day,	$.18	per	M	feet
"	"	1,750	"	"	"	157½	"	"	"	.21	"	"	"
"	"	1,500	"	"	"	135	"	"	"	.25	"	"	"
"	"	1,250	"	"	"	125	"	"	"	.26	"	"	"
"	"	1,000	"	"	"	110	"	"	"	.30	"	"	"
"	"	750	"	"	"	82½	"	"	"	.40	"	"	"
"	"	500	"	"	"	65	"	"	"	.50	"	"	"
"	"	250	"	"	"	45	"	"	"	.70	"	"	"

"If only one machine is yarding to a pole road, then this cost is doubled at least 85 per cent, and another unit of 3,000 feet would double the cost again and if only one yarder were used it would be quadrupled, so that it is very evident that the proper distribution of machinery is very essential."

It is difficult to estimate the output of a roading machine. In a general way it will depend upon the length of haul and the character of the road and timber. Under ordinary conditions a roader will handle 100 M feet per day when the haul does not exceed one mile.

Special Roading Devices.

Cable Grip.

Where the road is steep enough to cause the turn of logs to run, special devices have to be used. One of these devices is the cable grip. The writer in describing this device has quoted an operator.

"In our section of the country it is a common practice, on account of the topography of the country, to handle long-haul roads, that is, roads from one-half mile to two miles, wherever the logs are coupled together and snaked down over the road, usually with a 1½" cable that is handled with a large stationary engine. As a rule, considerable money is spent on the main roads, and in case of long or heavy hauls the road is practically skidded the entire length, or pole chutes built in portions of it, depending on conditions. The skid roads are usually made with 12 to 16-ft. cross skids, and skids generally placed about 5 feet between centers."

"In building these roads it is always desirable to get at least a four or five per cent grade, and from that on up to whatever the topography of the country calls for, grades as high as 50 per cent being many times reached. At the present time we have in operation two of these roads, from ¾ to 1 mile in length. One of them has a rise of 150 feet, in the first 2400 feet; from then on for a distance of 2000 feet the rise is 550 feet or an average of 27½ per cent. In the last mentioned stretch there is 1000 feet rises 350 and a portion of this rise, amounting to 160 feet in elevation, occurs in a distance of 320 feet, being a 50 per cent grade."

"I do not want to create the impression that these roads are built on straight lines. While, of course, as in any such work we will endeavor to get them as straight as

possible; still, if necessary to put in curves to cheapen the work, it is done, in which case the outside of the curve is elevated and shear skids put in."

"The question of the amount of logs that can be taken out over a road of this kind in a given time depends on the length of haul and other conditions, but could hardly be considered a limiting feature of the operations of the camp. As an instance of the above, at a camp that was working on a road about 1¾ miles in length and had grade conditions equally as bad as the one named above, in 1908, we averaged a little better than two trips per day over the road with an average load of 15 logs per trip, logs averaging about 1200 feet."

"The success of these hauls we attribute to the use of a cable grip by means of which the load is attached to the hauling line. Essentially this consists of two jaws which have a wedging action when the strain of the load is brought onto them and which causes the line to be automatically clamped between the jaws with sufficient force to haul the load. At any time the load starts traveling faster than the line, the jaws are released and the grip and all simply slide along on the main line. On this account the lines are not snarled up, blocks torn down or similar troubles; neither is there the amount of line breakage that would occur under other conditions, in that whenever the load slows down slower than the line, the grip takes hold gradually and the load, you might say, never

stops at all, as would be the case if it were rigidly fastened to the line in any way, or if there were a sliding ring attached to the load and it came up against what is known as a bull ring in the end of the main line.

"From the action of the line it is almost impossible for the bull donkey engineer to tell whether or not the load is running, and the only indication he has of it is a slight speeding up of his engine when the grip releases and the strain of the line is thrown off.

"The grip weighs probably 75 lbs. and is attached to the head log of the load by an ordinary set of head dogs, usually chain, and in a measure depending upon the road whether or not it is tied down on top of the head log or, as in many cases, simply suspended on the cable in front of the head log and not tied down. In some respects the latter method of fastening is preferable, especially with a very crooked road, as when the load can practically roll over entirely without affecting anything so long as the line does not foul under the load."

"The logs are coupled together with coupling grabs, which consist of grab dogs and socket babbiting on each end of 7/8" cable about 5 feet in length. In most cases two dogs are used on each log, crossing each other in the form of an X on top of the log, instead of coupling directly parallel with the log.

"The load is attached to the lower slide of a grip,

marked "A" (see drawing). Sliding loosely on that is a slide, marked "B". The pull or load is traveling that way. As the line tightens up the friction of the slides "B" and "C" is enough to slide past "B" on the slight incline on past "A". There is also toggle action through these two side straps which are fastened on these with large bolts. When the line starts up, the friction draws the toggle, causing it to grip, It also slides on these two projections enough to grip the cable tight enough to hold the whole load. As soon as the load starts running at all, going any faster than your line, the strain comes off of the back end, the toggle lets go and the cable grip and all travel along right down the line.

"A load never stops from the time it leaves the yarder until it gets in. When it starts running it simply uncouples, goes along down the road as fast as it pleases, and then as it slows up and gets any slower than the line, it automatically grips itself and is picked up and brought right in.

"We have very little trouble with breakage on the main line. The main line on one of these machines will last from three to four years. Three is not an uncommon life for a hauling line on one of those big road engines."

Ground Snubbing Device.

Another special device used on steep ground is the snubbing machine. Several different kinds of machines have been used - some homemade, others patented. The two following

described rigs are patented:

(1) The Lake Whatcom Logging Company near Bellingham used a snubbing machine in connection with their road work at one time. Mr. J. J. Donovan, in speaking of the work, made the following statements:

"The snubbing machine used by the Lake Whatcom Logging Company is manufactured by the Washington Iron Works of Seattle, and is very satisfactory. We are using it with one mile of 1" line to lower logs a drop of 500 feet in one-half mile, some of the grades being nearly 40 per cent. Logs are hauled on a skid road in turns averaging six logs by an ordinary road engine, a distance of one mile. At the head of the sharp incline the turn is stopped opposite the machine and attached to its cables by a 30' line with proper grabs. We fasten to the head log in wet and the rear in dry weather. A man takes his place at the machine brake, the signal is given, the road engine starts the turn and the man at the machine steadies it down the grade, stopping at the bottom to release. The machine is cheap, strong, simple and effective. Its essential features are a heavy cast iron frame supporting two 42" drums, one grooved for four turns, the other for five turns of rope and having a 12" brake band at the end. One man at the lever has complete control. A 1" film-steel cable twice the length of the incline is wrapped around the end of the drum in form of figure 8, four times, the free ends spliced after being run through a heavy 18" sheave which

is securely anchored at the lower end of the incline. Provision should be made in fastening this sheave to take up the slack weekly with the road engine. It is needless to say that the machine itself at the upper end must be securely anchored. Two rings are fastened to the rope when set, one at the machine and one at the lower end, and the turn is fastened to the upper ring. When that reaches the bottom the other is at the top ready for the next turn. The lines are laid just outside the road. We have not used the machine on curves. Swivels set in the line to relieve twist have not been of use, owing to the high tension. This has made necessary the use of a boom-hook or clamp, which can be released with a few blows of a hammer." This machine cost about $600.

(2) The following snubbing device was used at one time by the Chehalis County Logging & Timber Company of Montesano, Washington. Mr. Weatherwax of Aberdeen wrote of the machine as follows: "The device which was built by the Puget Sound Iron & Steel Works of Tacoma consists of a double drum on a single shaft, the drum revolving on same. The drum is built with two flanges, eight inches wide, and around these flanges are steel bands of the same width under which rest the friction blocks. These two brakes are connected with a rod running from one side to the other and attached to the brakes by a knuckle joint. A lever about six feet long is keyed on to this brake rod and is operated by means of a block

and tackle attached to the rod and to the sled or stump nearby. One man operates it by the use of this block and tackle a great deal easier than he could without one, because he gets four or five times the purchase he would if he simply pulled on the lever. The method of getting the main line back is very simple, as the haul-back line of the road engine at the foot of the hill is attached to one side of the drum and the snubbing line to the other. As the turn goes over the hill, it takes out the snubbing line and the haul-back is wound up on the other side of the drum. Consequently the snubbing line is taken back by the donkey at the foot of the hill by winding up the haul-back line which unreels it from the haul-back drum of the snubbing machine and must necessarily wind up the snubbing line, then you are ready for another turn. We have been lowering on a grade of at least 45 per cent anywhere from two to six logs at a time and taking the turns just as they were brought in by the donkey at the top of the hill. The hill we are operating on is about 1200 feet long and has a curve at the bottom. During the three months we have been operating the machine we have had just two accidents, but they were not of serious consequence. These accidents were caused once by the grabs pulling out and once by the grabs breaking. During the time of operation we have lowered between six and seven million feet of logs, some of the logs measuring eight and nine feet in diameter and forty feet long."

OVERHEAD ROADING

General.

It looks now as though it will become the common practice to road logs over a cable suspended in the air rather than over the ground. This is now done at several camps. The following is a brief description of two overhead roading rigs.

Washington Iron Works Aerial Snubber.

This rig is the same in principle as two of the rigs described later in this circular. It was first used to road logs at a distance greater than 1500 feet, which is the only reason for including it here rather than later on. It was first used by the Nestos Timber Co. Mr. Nestos, in speaking of the rig, made the following statements:

"The timber that is being taken out by this rig was regarded as quite inaccessible. It is on a bench and the side hill falls away so rapidly and so roughly that a pole road or chute was quite out of the question for the amount of timber there was to take. The idea of using an aerial line and lowering by gravity appealed to us, but the difficulty was getting a trolley to fulfil the requirements; that is, one to hold the log clear off the ground on the run down and allow it to lower on the landing at the foot.

"I called on the Washington Iron Works and found that they had patented a trolley for just such work as this. As it

was an experiment, we did not install a heavy rig, intending to try it on cedar poles and later get a heavier trolley. We are still using the light trolley and take down 100 feet of poles right along. A short time back we brought down a fir pole scaling 2000 feet.

"For snubbing we had a third drum with extra wide brake put in the yarder - a 10x12" half breed. A 1-3/8" cable was stretched from a deadman below the landing at the bottom, through a block on a guyed head tree on the bluff and made fast to a stump, the slack of the line being taken up by means of a line on the yarder gypsey, with a double block purchase. The logs are yarded to the foot of the head tree and the snubbing line which is rove through the trolley hooked on.

"It is then taken and hoisted up until a ball just above the line hook on the snubbing line engages with a grip on the trolley, and is held there, keeping the line clear of the ground.

"The load is now snubbed down to the landing, making the trip of 2500 feet in from 1 to 1½ minutes. At the point when the load is to be dropped there is a stop on the standing line which holds the trolley and frees the snubbing line from the grip, allowing the load to be lowered on the landing. The load unhooked, the signal is given, and the snubbing line is tightened up. When the ball on the snubbing line is hauled up short it releases the trolley from the stop,

and the rig travels up the line to the head tree. At the head tree there is a latch clamped on the line, which holds the trolley, preventing it from running down hill while the load is hooked on. The trolley goes back to the woods in 2½ minutes, and though it is being worked intermittently, it makes 50 trips a day. Working continuously it could easily make 75 trips a day or more. As the yarder chaser hooks on there is only one man needed for the rig - the one at the snubbing drum - and it can always take away as many logs as it would be possible to get with one yarder. Considering the fact that we are using the same donkey both for snubbing and yarding, it is economical in operation.

"Owing to the cheapness in the first cost and running expenses it can be worked to advantage under a variety of conditions on side hill work; for instance, on most hills one could yard up hill and let the logs down on the snubbing line cheaper than to yard down hill.

"Twenty-five hundred feet is quite a satisfactory span in our case. For steeper hill sides a longer line might be used, while for an easier slope the line would have to be shorter."

At the time the writer saw this rig in operation, the time of one donkey was given up to lowering the rig. Two men unhooked the logs as they were brought to the head tree and hooked up for the snubbing rig. An engineer, foreman, and one-

half the time of a woodbuck was charged against the snubbing engine. This rig should take care of the output of two yarders or from 100 to 120 M feet per day. The superintendent stated that the heaviest load they had handled amounted to about 2500 feet. They never had found it necessary to handle heavier loads.

Double Aerial Snubber.

The Hammond Lumber Co. of Mill City, Oregon, is using an overhead snubbing device to lower logs down a 33 per cent grade. The device in use consists of two parallel standing lines, 1800 feet long from head to tail tree, and 1½ inches in diameter. The lines pass through shoes on the upright supports and are anchored at the ground to stumps or "dead men". On each standing line a three-sheave trolley is operated. The third sheave in the trolley is merely for maintaining the upright position of the block. This precaution is necessary both when the trolley is carrying the load and when it is returning empty. The power is furnished by an ordinary 10x13" Willamette donkey, stationed at the lower end and equipped with a ¾" main line.

The system requires the services of five men in addition to the regular yarding and loading crew. It requires about three minutes' time for the log to be lowered, at the end of which time the empty carriage has been returned to the woods.

If worked in fair sized timber the rig would have a capacity of about 150 M feet per day.

UNLOADING

General

Logs as a rule are dumped into ponds, streams or tidewater. Very small operators sometimes unload logs to, and store small quantities on, the land. The latter is an unusual practice on the Pacific Coast, and will not be discussed.

As a general thing the improvements used consist of a rollway or dump and an unloading machine. Where the logs are dumped into the water the railroad track may be built along the bank of the stream or pond. In the case of unloading into ponds the track is built along the bank. In the case of streams the track may be built along the bank or else extended over the water on piling. To dump logs into the tidewater, it is necessary to extend the track over the water.

A number of different devices are used in unloading logs. Two general principles are used. The logs may be pushed from the cars, or through a super-elevated track, they may be pulled from the car by gravity. The two principles may be combined in a given device.

The aim of all operators, of course, is to unload logs as cheaply as possible. This step in the logging operation, however, must be considered in connection with the cost

of other steps in the logging operation and the total amount of timber to be cut. In other words, there should be a nice balance between the labor cost of dumping the logs and the following: The total cost of transporting the logs from the landing to the dump, the total cost of booming and sorting, and the cost of building and maintaining the unloading improvements. This is particularly true of the balance as it relates to the transportation of the logs. With this in mind, it is obvious that the unloading method and improvements in a particular case will depend on a number of factors, on which it may be well to dwell briefly. There is also a relation between the cost of the improvements and methods.

As has been suggested some methods are more elaborate, and the total daily cost is larger than others. It would seldom be economical to install a device that would handle a large output, say 300 to 400 M feet per day, when the daily output was not more than 50 M feet. On the other hand, if the logging train were crowded because of a long haul, it might be economical to put in comparatively expensive rig and employ more help than the loading in itself would justify. As a general thing the train crew constitutes all, or the major part, of the help in unloading. This means that the train is held at the dump until the logs are unloaded; that if the logs are unloaded slowly, the railroad equipment is idle during a large part of the day.

Running water outside the dump simplifies the operation by keeping the logs out of the way. If the water is still but deep the difficulty is not greatly increased, as the disturbance of the water caused by the falling logs is sufficient as a general thing to keep the dumped logs out of the way. Shallow water, however, is a serious drawback. If the logs do not float away, there will be more or less breakage when the logs are thrown in on the pile that forms. This is especially true of cedar. This suggests that different methods and rigs will be used in connection with dumping logs in rivers, mill ponds, and on the tide flats.

If the water is deep and has a current, the dump may have only one track and be comparatively short, and the unloading rig may be stationary. While it has been pointed out that still, deep water does not increase the task of unloading logs greatly, such conditions do constitute a drawback, and, in some cases a serious drawback. If the logs are being dumped rapidly, the disturbance on the water caused by the falling logs will not be sufficient to keep the logs from piling up and an extra man may be employed. If the body of water is narrow or shallow and the output of the camp is large, it may be found economical to build a long dump and use a self-propelling unloader in connection with a double track. This latter method would also be used where it was desired to dump the logs at different points to facilitate booming and sorting.

Some of the factors that indicate the method to be used have been pointed out. At the same time it was seen that there was a direct relation between the method and the type and cost of the improvements. For the purpose of clearness we will separate the improvements into: dump and unloading rig. Unloading machines are described with the discussion of unloading methods given later on.

Dumps.

Where the track is built along the bank of the stream or pond it is generally necessary to construct an incline rollway over which the logs may be rolled into the water. The length, breadth, pitch of skids, strength of structure, etc., will depend on the topography and formation of location, size of logs, method of unloading, etc. It might consist of a frame work composed of three parallel sets of stringers, spaced about 8 feet apart, which extend along the water's edge for from 60 feet to any distance, depending on the length of rollway desired. The outer stringer, possibly the second, projects over the water's edge and is supported on piling or on timbers that rest on solid bottom. The other stringers or stringer are generally supported on round or square timbers. The piling and upright timbers are placed from 4 to 6 feet apart, depending on the formation and the size of the logs unloaded. Heavy round timbers are placed on top of and at right angle to the stringers, and have a pitch of from 15 to 25°. The round

timbers are generally laid flush, forming an unbroken floor. Iron shoes, made of railroad iron, are placed on top of some of the round flooring timbers and at right angles to the stringers so as to be from 4 to 6 feet apart. These timbers and shoes serve as a bed over which the logs are rolled. The upper ends are placed a little below the level of the top of the car bunk. The track is laid parallel with the rollway and close enough so that the ends of the car bunk will be about 6 inches distant.

Quite often, as has been indicated, the track is built on piling either over the water or else alongside the bank. The trestle as it relates to the dump proper may be long enough to accomodate twenty cars or more. An additional length of trestle may be necessary to get the logs to deep water. To protect the trestle from falling logs, a row of piling is driven flush with the end of the ties. These piling, forming in some cases an unbroken wall, are cut off so that the top of the brow skid which forms the cap is a little below the top of the car bunks. An unbroken wall of piling is usually placed just outside the first row, the piling being beveled off at the top. The railroad track is laid parallel to the brow skid, or vice versa, and close enough so that the top of the car bunks will be a little higher than the top of the brow skid. If a stationary unloading machine is to be used the dump proper will not be more than 60 feet long and will be placed at the most advantageous point, taking into consideration the depth of the

water and the cost of the succeeding step of the logging operation - booming and sorting.

The cost of building and maintaining log dumps will, of course, vary with locations and methods of unloading. It is obvious that the cost will vary greatly. The writer cannot give the cost and description of any dump, but such cost would only serve as a guide. It is thought that any one who knows the type and size of dump required in a given case can estimate the cost within a reasonable degree of accuracy. The cost data given under the head of "Transportation" will help some. Further assistance can be secured from cost data published for railroad engineers. The price of piling, and the contract price for driving, can be secured; also the cost of timber. The most difficult thing, however, will be to decide on the type and size of dump required. If the trestle is built over salt water and subject to the attacks of teredos, the maintenance cost will be much higher than where it is built over fresh water.

Unloading with Logging Jacks.

It may happen that the depth of the water makes it necessary to dump the logs at different points along the dump rather than at one point. Under such conditions if the daily output of the camp is large and the main line logging locomotive is kept busy transporting the logs to the dump, a self-propelling steam log unloader will be employed. If, however,

the train crew is not crowded it may be found more economical to have the train crew unload the logs with logging jacks. The track being super-elevated, gravity will unload some of the logs. Those remaining will be pushed off with jacks.

At one camp where the unloading is done by this method, a crew of three men - two brakemen and a dump man - unload eight cars, averaging about 7500 feet to the car, in about thirty minutes. This work is seldom accomplished in less than twenty minutes, and it sometimes takes as long as one hour. The brow skid is too high, causing a considerable loss of time. The logs average about 8000 feet in volume.

Gin-pole-line Method.

Some operators find it economical to use a gin pole or beam with a line in unloading. The pole or beam is located along the track on the land side. The line leads through a block on the pole, or blocks on the beam. To unload, the line is passed under the load and the hook made fast on the brow skid. The power is applied, and the line tightened. This action raises the load free of the bank, and at the same time pushes it off from the car.

The power may be furnished by the locomotive, or a single drum donkey loader, or hoist. If the logs are being unloaded into a mill pond, a hoist may be used - the steam being furnished by the mill. At one mill they used a 6¼x10" hoist which was placed 50 feet from the gin pole. The unloading line

was 7/8" in diameter. The unloading was done by the train crew, the locomotive fireman operating the hoist.

Where a donkey engine furnishes the power, it is necessary to have an engineer with the machine all the time. It is quite the common practice to use an old donkey yarder or loader, the location of machine depending on conditions.

A large number of the camps using this rig develop the power by running out the line with the locomotive. It is obvious that where the locomotive has to both spot the cars and run out the line, the method is slower than where the cars are spotted with the locomotive and the line is tightened by a hoist. With a given train crew, unloading proceeds more rapidly with a donkey engine than with a hoist, since with the donkey engine the locomotive only has to spot the logs.

The time consumed in unloading with this rig varies. With it unloading proceeds possibly at the rate of about 1½ to 3 minutes to the car.

Tilting-dump Method.

This method is used at several camps. It no doubt has its advantages and disadvantages the same as the other methods. The dump here discussed is built in pairs, each 40 feet long with 30 feet of stationary track between. This arrangement permits logs of any length to be dumped. Two cars containing logs up to 40 feet can be spotted at once and dumped. To dump longer logs one truck is spotted on each dump and the

dumps tripped simultaneously.

Piles capped with timbers form the foundation. The roller timber - a stick 42 feet long by 20 inches square - two stringers, and a floor of ties and latch timbers above them, make the platform of the dump upon which the track is laid. The latch timbers - five on each dump - extend about two feet beyond the ties on the land side and are fastened down by iron latches, holding the stump stationary while the train is crossing. The center latch timber, known as the trip timber, is longer and larger than the others, being 36 feet long, 9 inches thick, and 18 inches wide at one end, tapering to 12 inches at the other. The axis works on a set of heavy cast iron chairs, which chairs rest on the sills. The ends of the roller are shod with cast iron cylinders.

The operation is simple, the cars being spotted, chains taken down and latches knocked off. The center of the track is placed about 3 inches to the water side of the center of the roller timber, so that upon the removal of the latches the weight of the car causes the platform to revolve 15° on its axis, and the logs roll off. The dump is then brought back to position by the men walking out on the trip timber. Loads heavy on the land side will not trip the dump. Such loads are started by prying up on the trip timber. Slabs will not always roll off at this inclination and to take care of these a gin pole and line are used to throw them off, the power being furnished by the locomotive. With three men working - two brakemen and

locomotive fireman, the average time used is about 2½ minutes per carload - a large part of this time being used in taking down and putting up the binding chains. If the trucks were equipped with the "turtle-back log bunk and car stake" the time consumed in unloading would be considerably less than this.

"The cost of the dump will vary with different locations, and the nature of the ground built upon. We encountered some quicksand and on that account put more piles in the foundation than was ordinarily planned. The double dump complete can be built for a little more than $2,000 in any ordinary 'show'. This does not provide for the timbers used (or the approaches). We get out our own piles and hew the timber, charging the dump for the labor but not the timbers. The maintenance for the past seven years has been about $300 per year. During that time we have rebuilt the dump complete, the cost of rebuilding naturally being less than the cost of first building, - some of the piles and timbers and most of the iron being used in a second construction.

The dump has met our requirements well. Accidents to those working on it have been few. It is not hard on trucks or other equipment, and has taken care of any output we have had. We are now dumping about 350 M feet per day and could take care of much more."

For diagram showing detail of construction of tilting log dump see the August, 1912 issue of "The Timberman" or "Logging" by R. C. Bryant.

Gill-poke Method.

Rigs of different degrees of elaborateness, all making use of the same principle, may be observed. One of the simpler devices is as follows: The rollway or dump is constructed with the rail on the water side several inches lower than the outside. Parallel to the track is a timber with notches cut out at proper distances. The arm of the gill-poke is a stick of wood 4x3½" and 6' to 8' long, shod with a sharp steel prong at the pointed end, with a collar at the blunt end. When the loaded train is being run in, the pointed end of the arm is placed against the logs while the "heel" is inserted in one of the notches in the timber. This results in the logs being pushed from the cars. Thirty-two cars containing 150 M feet have been unloaded with this rig in 15 minutes.

Four-sweep Gill-poke.

This machine consists of four arms hung from a center pile that is about 14 feet above four other piles that support it. The sweeps or arms are 30 feet in length, the center pile being so located as to enable them to reach across the track when the device is in operation. The sweeps are hung so that they can be raised or lowered four or five feet. This is an important feature as large logs should be struck with a sweep higher up than small logs.

Two-sweep Gill-poke.

The two-sweep gill-poke consists of two steel arms 17' long made of channel and angle iron. The arms are 18" wide except at the ends, where they are made 36" wide to give a broad surface to repel the logs. A heavy casting carrying a sharp edge is attached to the outer end of each arm. The two arms are bolted opposite to each other on a 24" journal, and are braced with a turn buckle. The arms and journal are set on a shaft 11' long, and 10" in diameter, cut down to 8" where the journal is fastened to admit the attachment of a collar with ball bearings. The shaft is set in a concrete base, high enough to allow the arms to clear the car bunks, and far enough distant so that when the arms extend across the track at right angles it reaches one foot beyond the outer rail. To unload a trainload of logs the loaded cars are pushed up to the rear of the unloader, a loader arm is swung up against the log and the train put in motion. The sharp edge of the arm grips the log and as the train advances the arm is turned on its axis and the log or logs are gradually shoved off the car. As soon as the logs are dumped a man places the other arm in contact with the logs in the succeeding car. It is seldom necessary to stop the train, which is moved slowly during the entire operation. "The average time consumed in unloading 75,000 feet of logs from 15 cars is eight minutes." The cars are equipped with the "turtle-back log bunk and car stake".

One of the companies that has used this rig for three years has "never spent a cent for repairs, the only cost of maintenance up to this time being about a gallon of oil consumed annually for lubricating purposes".

The cost of making and installing one of these rigs, exclusive of the cost of excavating, which would vary with the conditions, was about $1,000; $900 for making and $100 for installing.

One-sweep Gill-poke.

A swinging boom or arm, which is shod on the engaging end the same as the arms on the two-sweep rig which has just been discussed, is attached to a clump of piling. The arm engages the logs in the same as other gill-poke rigs, pushing them from the cars. A line fastened to the arm leads through blocks on another piling. A weight is attached to the free end of the line, which weight pulls the boom back into position to engage the logs on the succeeding car.

This is a very satisfactory rig and where the cars are equipped with the "turtle-back log bunk and car stake" will probably unload logs as rapidly as the two-sweep rig which has been described. The machine is guaranteed by the inventor to unload one car of logs per minute, and if the cars are equipped with the Knight chock block, he guarantees that it will unload three cars in two minutes. The "turtle-back log bunk and car stake" is probably better adapted for increasing the speed of

the rig than the Knight chock block. In February, 1911 there were 24 of these machines in use on Puget Sound.

The total cost of making and installing this machine is approximately as follows:

Installing - -	$300.00
Making (irons, royalty, etc.)- -	400.00
Total cost, from	$700.00 to $1000
according to place of location	

Unloading-engine Method.

Where it is not practical to dump all the logs at one spot or where it is desirable to dump them at different points, it may be found necessary to use a self-propelling unloader, which runs on an independent track along the main track. Moving from car to car the machine unloads each one in rapid succession. To unload, the line is passed under the load and the hook made fast on the brow skid. The friction drum is thrown in, and the line tightened. This action raises the load free from the bunk, and at the same time pushes it off. This machine can also be used as a general utility car for bridge building, picking up stray logs along the track, track building, wrecking car, etc.

Cost of Machines.

There are at least two types. One has a stationary boom, single drum and reversible engines; the other has a live drum, necessitating the use of two drums. A live boom increases the use of the machine as it is possible to reach out over the

pond to break out jams or pick up loads from barges. The engines on this type are not reversible; going ahead and backing is accomplished by change gears. The machines have a capacity of about twenty tons, and will run over an eight per cent grade.

In May, 1913 the prices on the unloaders built by the Willamette Iron & Steel Works were:

"Chapman" (stationary boom) - - - - - - - - - -	$2500.00
"Whitney" (live boom) - - - - - - - - - - - - - -	3500.00

Crew.

As far as the writer knows the work of unloading for the most part is done by the train crew, assisted sometimes by members of the booming-and-sorting crew. If the output of the camp is very large, an engineer will be with the machine all the time.

Cost.

Since the work may be done entirely with the train crew; or the train crew with the assistance of members of the booming-and-sorting crew; or by the train crew, members of the booming-and-sorting crew, and an engineer with the machine; any cost per M feet for unloading with this machine appearing in a cost statement will not mean much.

Since the use of the machine necessitates a second track alongside the main track, the cost of constructing the dump is greater with this method than with others, and must be taken care of in any total unloading cost segregation. The same thing is true of the machine.

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It is, of course, quite impossible to say exactly how fast logs are unloaded with this rig. Possibly a car is unloaded on the average in one and one-half to two and one-half minutes.

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